

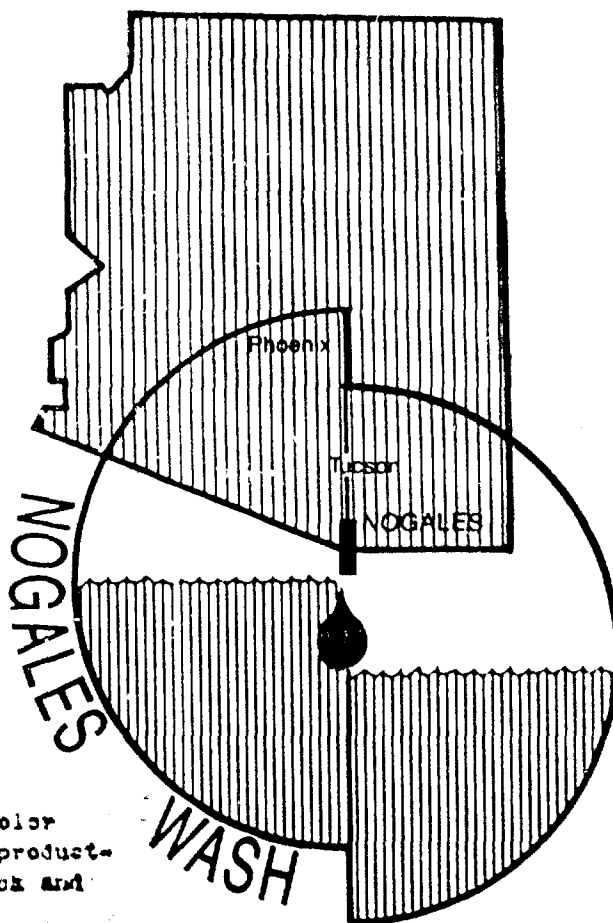
Feasibility Report
And Environmental Assessment

Nogales Wash & Tributaries

Nogales, Arizona. *REVISED*

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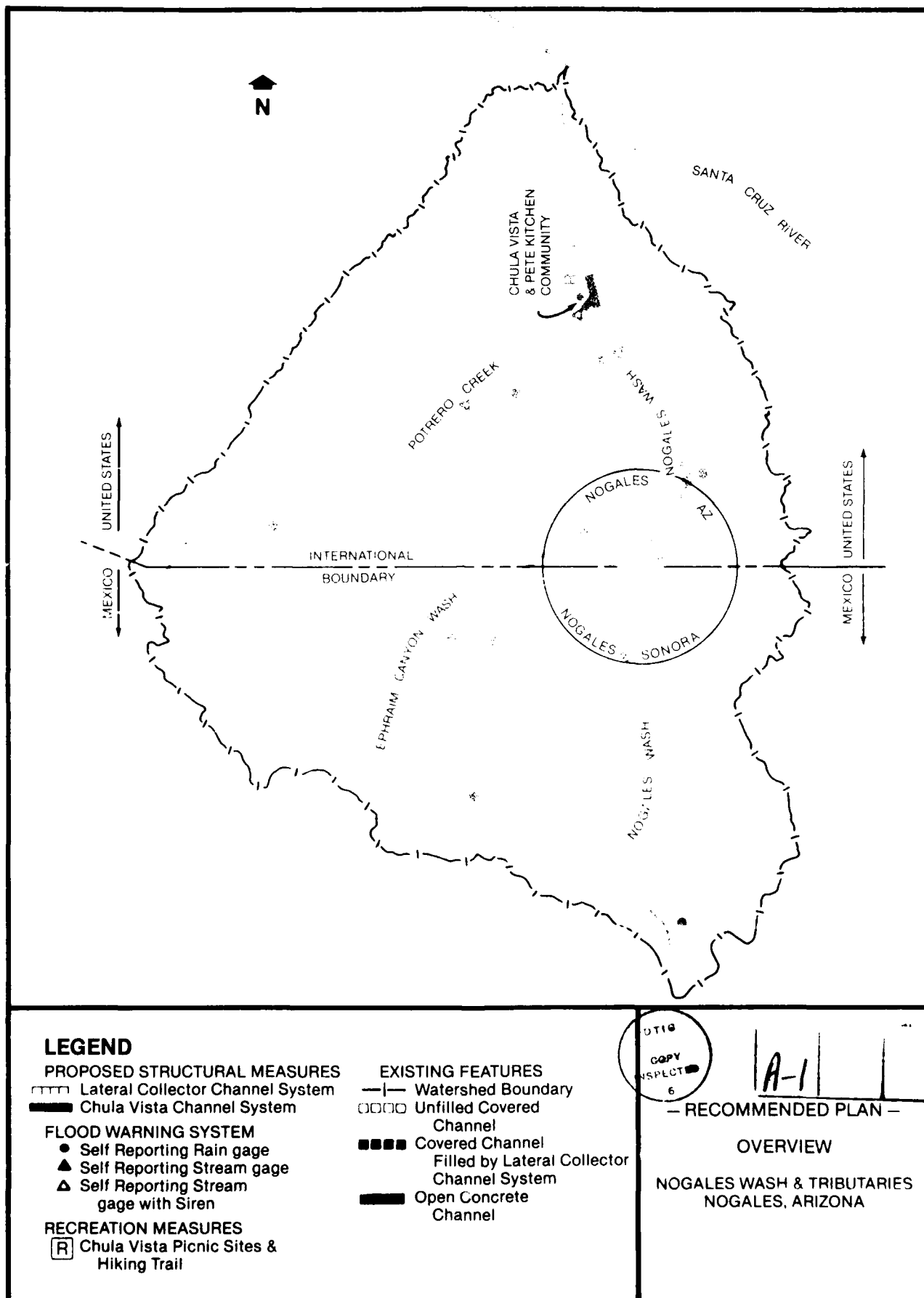
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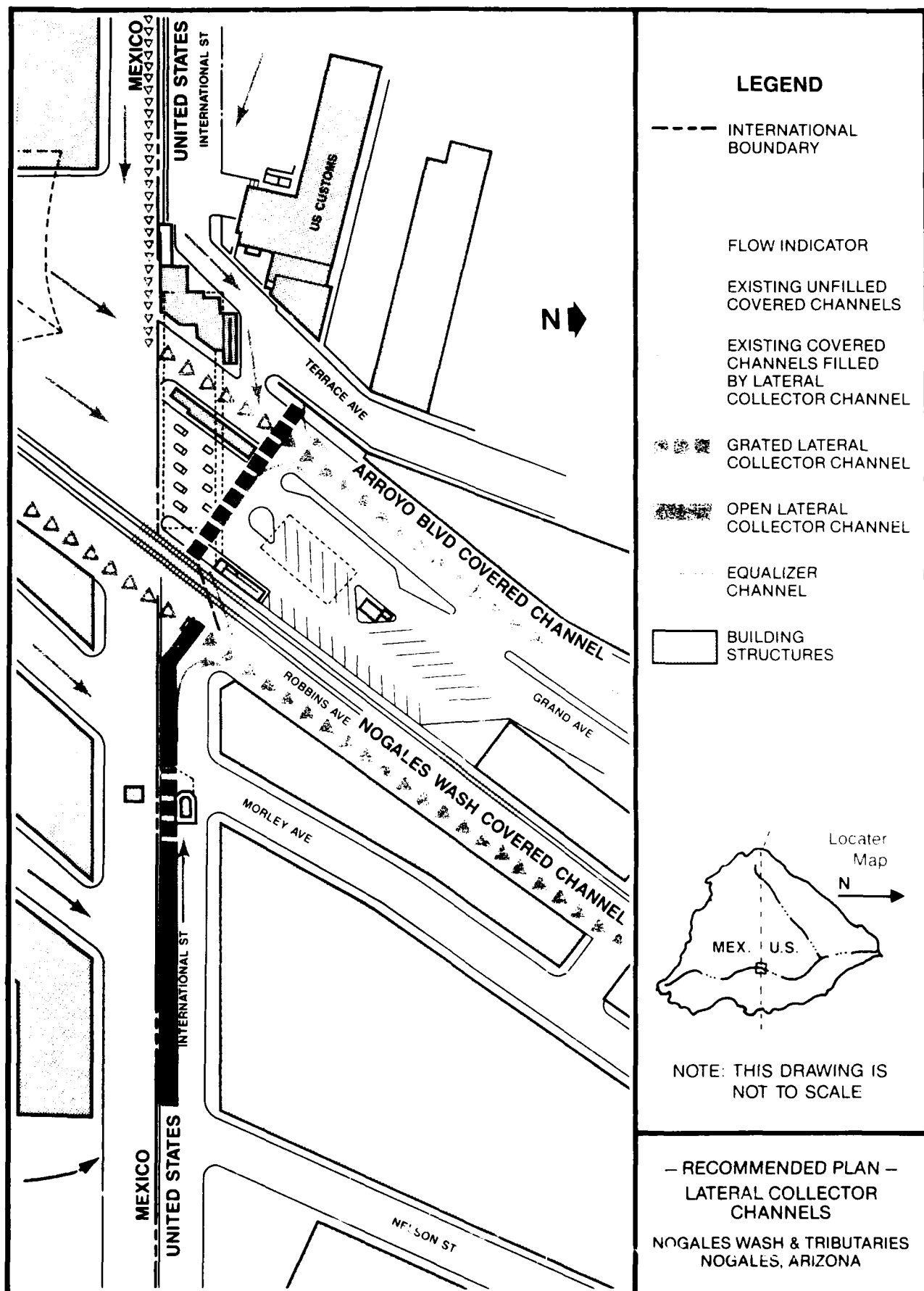
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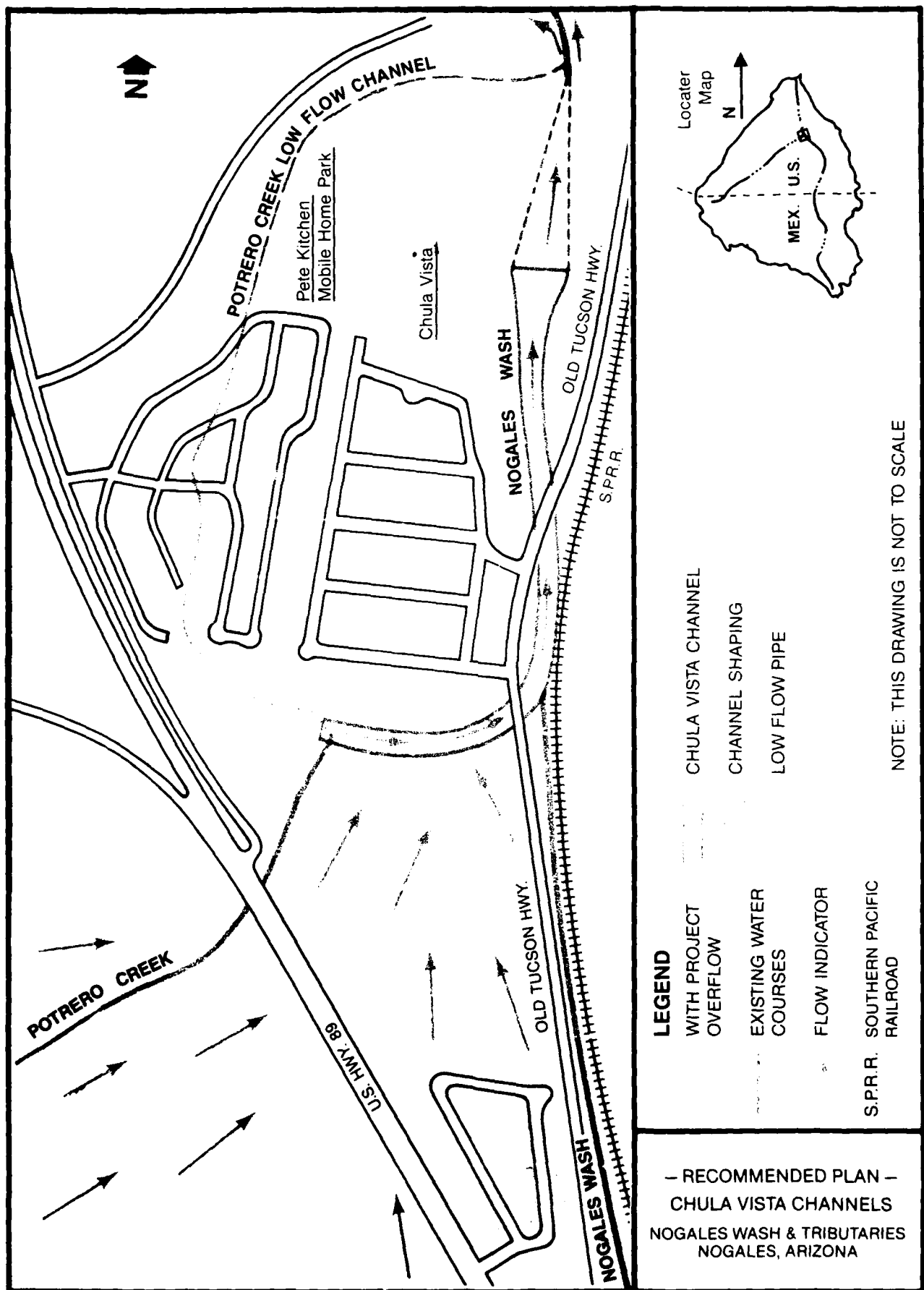
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Nogales Wash and Potrero Creek have suffered major damages from floods. This report considers a wide array of fllood protection measures. As a result of this study the National Economic Development Plan was identified in part as a 33-year future level of protection plan for downtown Nogales, Arizona to the outlets of an existing flood control channel system. Full consideration was given to engineering, economics, environmental, and social values.		









REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2711
LOS ANGELES, CALIFORNIA 90053-2325

NOGALES WASH AND TRIBUTARIES
FEASIBILITY REPORT
and
ENVIRONMENTAL ASSESSMENT

SEPTEMBER 7, 1988

NOGALES WASH AND TRIBUTARIES
NOGALES, ARIZONA

SYLLABUS

This feasibility report is submitted in partial response to the Flood Control Act of 1938 (Public Law 761, 75th Congress), which authorized a survey for flood control at various locations including the Gila River and its tributaries, therefore including Nogales Wash. This study was initiated at the request of Santa Cruz County to investigate flood control and related water resource problems.

Nogales Wash, which rises 7 miles south of the border in Sonora, Mexico, flows through Nogales, Sonora, Mexico across the International Boundary into the downtown Nogales, Arizona, community, and on to its confluence with Potrero Creek near the Chula Vista community. Potrero Creek then flows northward to its confluence with the Santa Cruz River, 8 miles north of the boundary. Flood flows from Nogales Wash and Potrero Creek pose a serious threat to the Nogales, Arizona community where a mix of residential, commercial, industrial, and public properties are subject to major damage on almost a yearly basis. Approximately 2000 residents who reside in the floodplain of Nogales Wash/Potrero Creek and an additional 1600 who reside in the floodplains of adjacent tributaries, live in fear of their lives.

A wide array of flood protection measures were considered including non-structural and structural alternatives and a no-action plan. Studies considered flood protection and other water resource measures along the entire Nogales Wash/Potrero Creek watercourse from the International Boundary to the Santa Cruz River. As a result of these studies, the National Economic Development Plan was identified in part as a 33-year future level of protection plan for the downtown Nogales, Arizona community from the International Boundary to the outlets of an existing flood control channel system approximately 1 mile downstream or north of the border; 100-year future level of protection for the Chula Vista/Pete Kitchen community; a small recreation component; and a flood warning system for the developed areas of the watershed. In the development of the Recommended Plan, full consideration was given to engineering, economic, environmental and social values.

The Recommended Plan provides for channel improvements at two locations. The first is the "lateral collector channel" located on the U. S. side of the International Boundary. This channel would capture overland flow emanating in Mexico and transition it into two existing, but unfilled covered channels. The second channel system, located at Chula Vista, would capture breakouts of Nogales Wash and Potrero Creek and carry the flood flows around the community in a new 3300 foot long grouted stone/concrete channel. Mitigation measures to ensure no net loss of riparian habitat over the project life, will be incorporated into the Chula Vista portion of the plan. Landscaping and aesthetic treatment along the channel will be used to satisfy a portion of the mitigation requirements. The Recommended Plan also

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includes a Flood Warning System that would reduce both flood damages and the threat to human life, and a small recreation component associated with the Chula Vista Channels.

The bulk of the text in this report was prepared using October 1986 price levels with an 8 7/8 % amortization rate. At the time of this Final Report, however, October 1987 price levels are in effect with an 8 5/8 % amortization rate. The following quantitative summary of the Recommended Plan, and that contained within the chapter on "Recommendations" have been updated to October 1987 price levels and an 8 5/8 % amortization rate. The figure in parentheses are based upon the original October 1986 price levels at 8 7/8 % amortization rate and will allow the reader to compare and make a direct correlation back into the bulk of the report.

It is recommended that, subject to certain conditions of non-Federal cooperation as outlined in this report, the proposal for flood control along with the flood warning system and recreation component, be authorized for construction. The total first cost of the project is estimated at \$6,162,600 (\$6,022,600). The Federal share of the estimated cost would be \$4,616,100 (\$4,511,200) and the non-Federal share would be \$1,546,500 (\$1,511,400) to include \$1,022,100 (\$999,600) in lands and relocations. Average annual costs for the Recommended Plan are estimated at \$558,900 (\$561,900); average annual benefits at \$1,247,500 (\$1,214,750); the benefit to cost ratio is 2.2 to 1. Following construction, non-Federal interests would be required to maintain and operate all project features. Annual operation and maintenance is estimated at \$11,200 (\$11,000).

The local sponsor of the project is the Santa Cruz County Flood Control District. The Santa Cruz County Board of Supervisors has provided a letter of intent to cost share in the construction phase as per the "Water Resources Development Act of 1986".

As a result of the unique relationship of the proposed flood warning system to Mexico (several gages are located in Mexico), it is recommended that the Corps of Engineers, in coordination with the International Boundary and Water Commission, acquire any necessary lands, easements and rights-of-way; and install, maintain, repair, and replace all necessary components for these system facilities in Mexico.

It is recommended that the plan described herein for flood control and recreation be authorized for implementation as a Federal Project, with such modifications as in the discretion of the Chief of Engineers may be advisable, and subject to the cost sharing of the Water Resources Development Act of 1986 (PL 99-662).

The recommendation contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect budgeting and programming priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorized and/or implementation funding.

NOGALES WASH
AND TRIBUTARIES
ARIZONA

FEASIBILITY REPORT AND
ENVIRONMENTAL ASSESSMENT

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NOGALES WASH
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FEASIBILITY REPORT AND
ENVIRONMENTAL ASSESSMENT

FEBRUARY 1988

CHAPTER I
INTRODUCTION

A. STUDY AUTHORITY

The Nogales Wash and Tributaries Study, (hereafter NWTs) was authorized as part of the overall Gila River and Tributaries, Arizona and New Mexico Study Authority in accordance with the Flood Control Act of 1938 (Public Law 761, 75th Congress), Section 6, which reads in part as follows:

"The Secretary of War is hereby authorized and directed to cause preliminary investigations and surveys for flood control including floods, aggravated by or due to tidal effects at the following named locations, ...

Gila River and Tributaries, Arizona and New Mexico ..."

This study was funded for the reconnaissance phase as a separate study in FY 1984. The report is in partial response to Section 6 of PL 75-761.

B. STUDY PURPOSE

The purpose of this study is to identify and investigate the current and future problems, needs, and opportunities associated with flooding and allied purposes in the Nogales, Arizona area. This report presents and discusses the results of the plan formulation process and identifies specific details of the Selected Plan.

C. SCOPE OF STUDY

The overall Nogales Wash Study area (Figure 2) is the 94 square mile drainage basin which includes Nogales Wash to the confluence with Potrero Creek (approximately 13 river miles), and Potrero Creek to its confluence with Santa Cruz River (approximately 4 river miles), in the vicinity of the City of Nogales, Santa Cruz County, Arizona. It should be noted that the upstream portion of this drainage basin (48%) is in the Republic of Mexico.

In early scoping meetings, Santa Cruz County Flood Control District (SCCFCD), the study sponsor, requested that the Corps study flooding and erosion problems along Nogales Wash from the United States/Mexico Border through the developed areas and along Potrero Creek. It was also requested that the Corps investigate similar problems associated with the International Sewage Treatment Plant, located at the confluence of Potrero and the Santa Cruz River.

During this investigation, many alternatives were developed to assist in solving these water resource problems. From these alternatives various plans were developed on the basis of support from local interests, environmental and social acceptability, and economic feasibility. Detailed studies of these plans were conducted and the most appropriate plan of improvement selected.

D. STUDY PROCESS

As a Corps preauthorization study, the NWTS was authorized and carried out under the Corps' two phase planning process. The first or reconnaissance phase, had the following objectives:

- * To define the problems and opportunities, and identify potential solutions.
- * To determine whether or not planning should proceed further, into a feasibility phase, based on a preliminary appraisal of the Federal interest, costs, benefits and environmental impacts of the identified potential solution.
- * To estimate the resources (costs, time, and manpower) required to conduct the feasibility phase.
- * To identify the local sponsor(s) for the feasibility phase and to procure an approved cost sharing contract for local participation in the feasibility phase.

These objectives were met in the reconnaissance phase in October 1984 and the feasibility phase was initiated in April 1985. The feasibility phase was performed by the Corps and the sponsor with equal cost sharing of study effort to determine whether a specific action to solve water resource problems should be recommended for Congressional authorization. These investigations typically are detailed studies conducted for decision-making purposes. They identify the existence of problems and needs, present feasible alternative solutions, compare their favorable and unfavorable impacts, determine associated costs and benefits, and recommend a specific course of action.

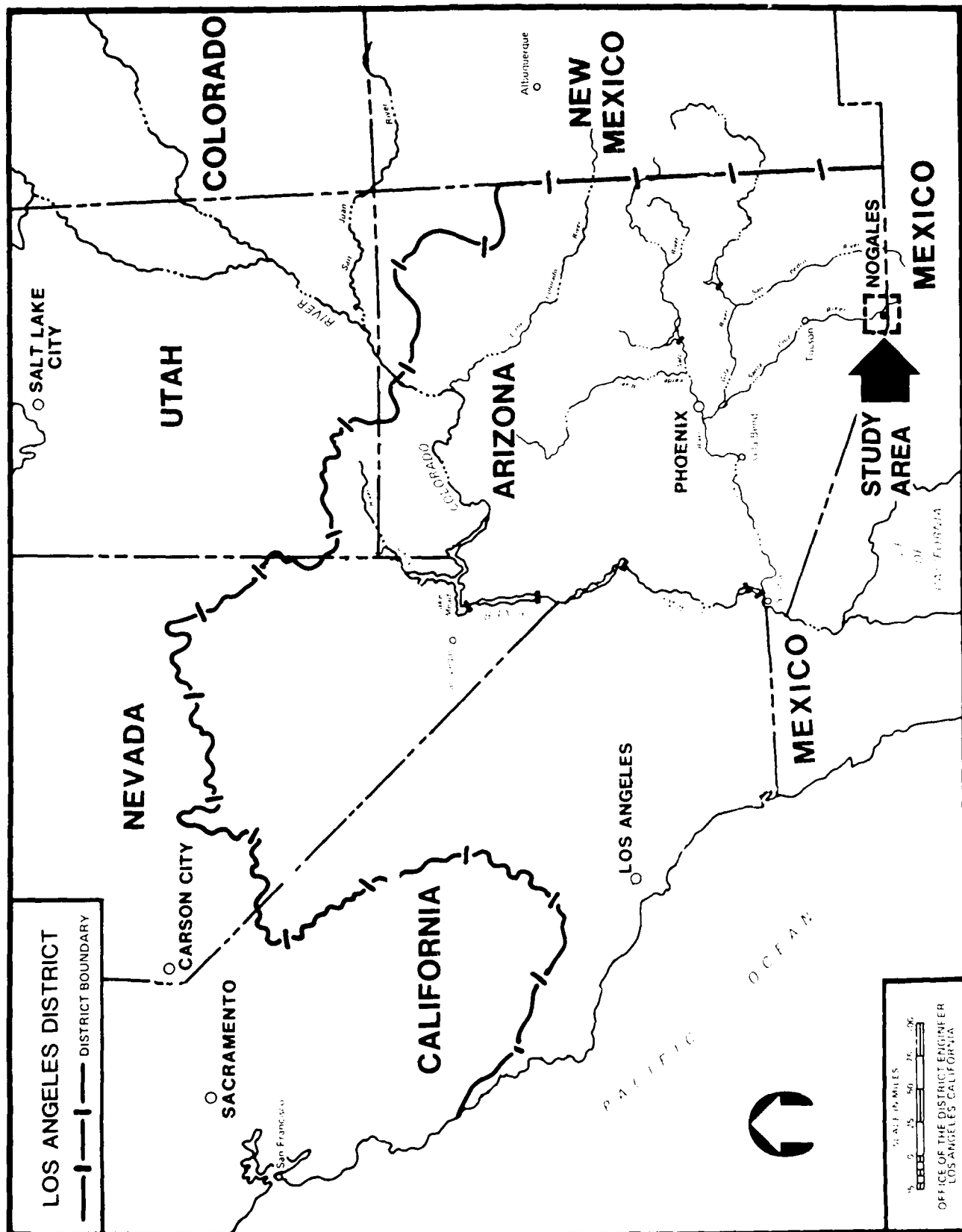


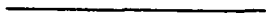
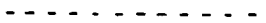
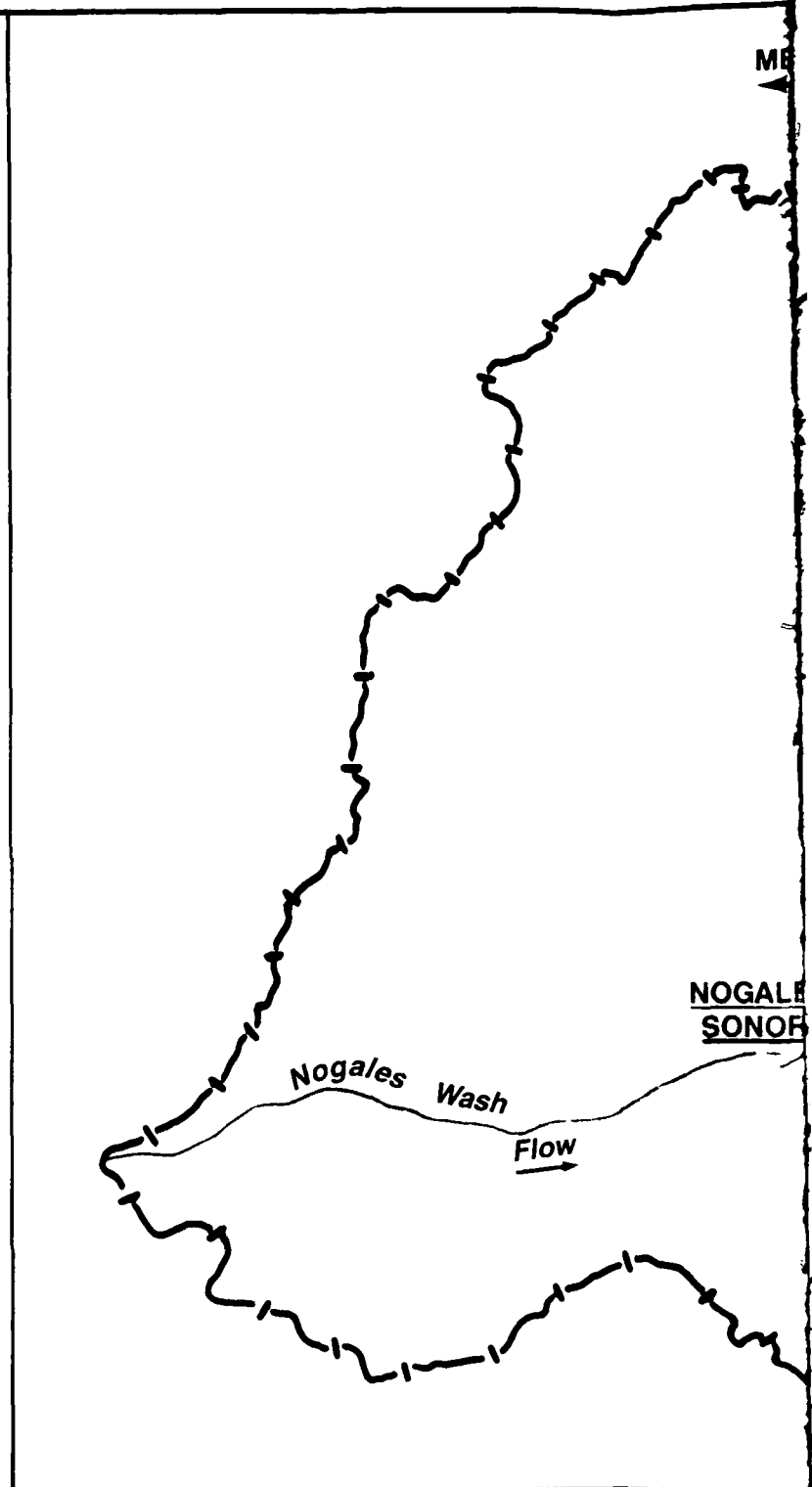
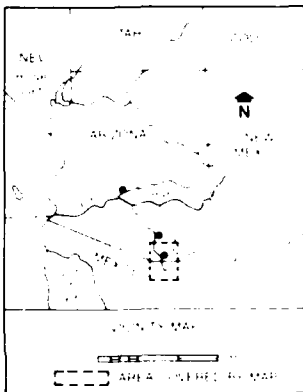


Figure 1
NOGALES WASH STUDY AREA
LOCATION MAP

LEGEND

-  Nogales Wash
Study Area/Drainage
Basin Boundary
-  International Boundary
-  Open Water Course
-  Covered Water Course



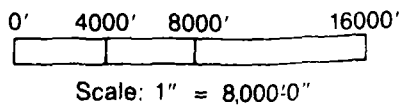
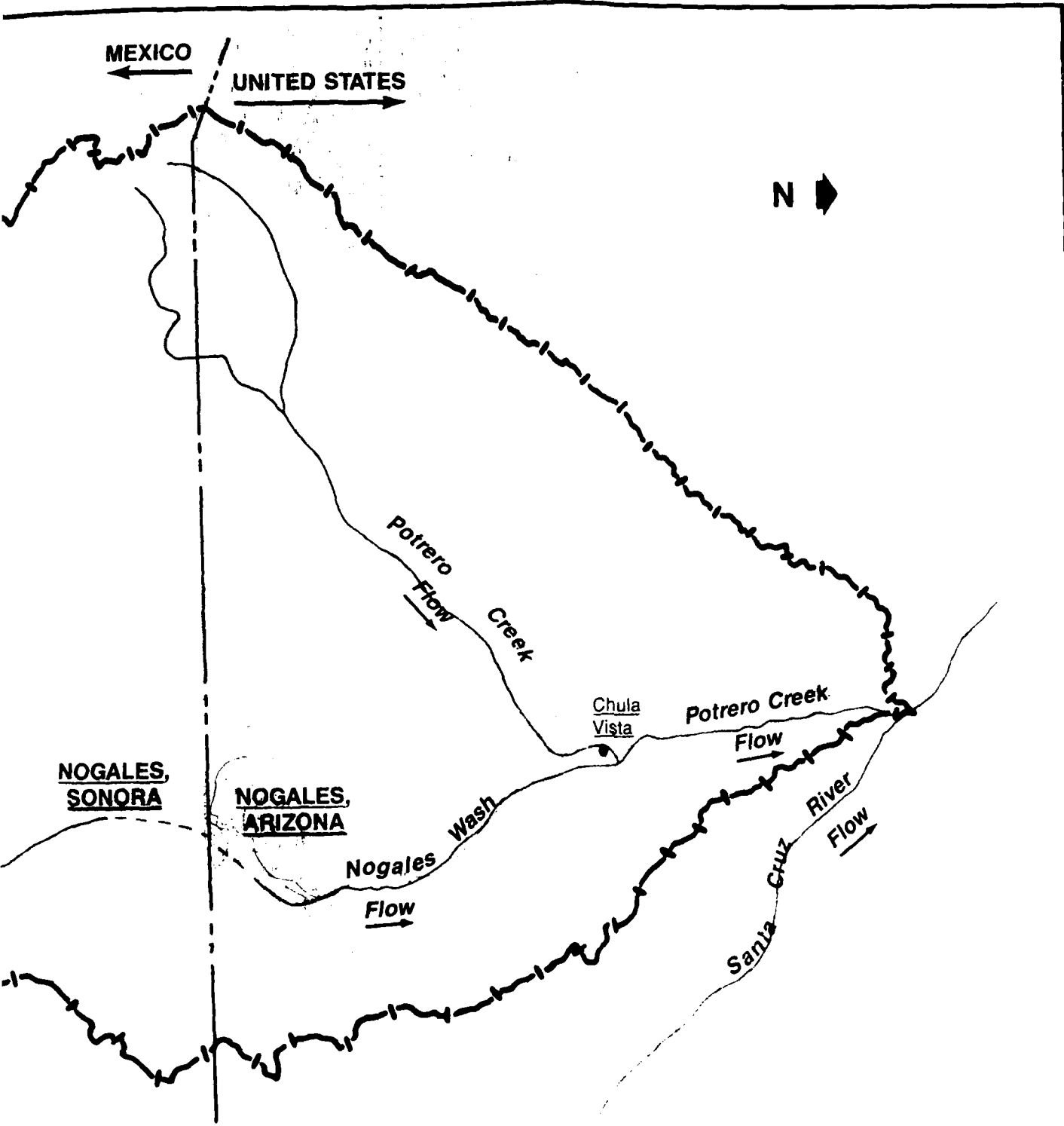


Figure 2
NOGALES WASH/POTRERO CREEK
STUDY AREA

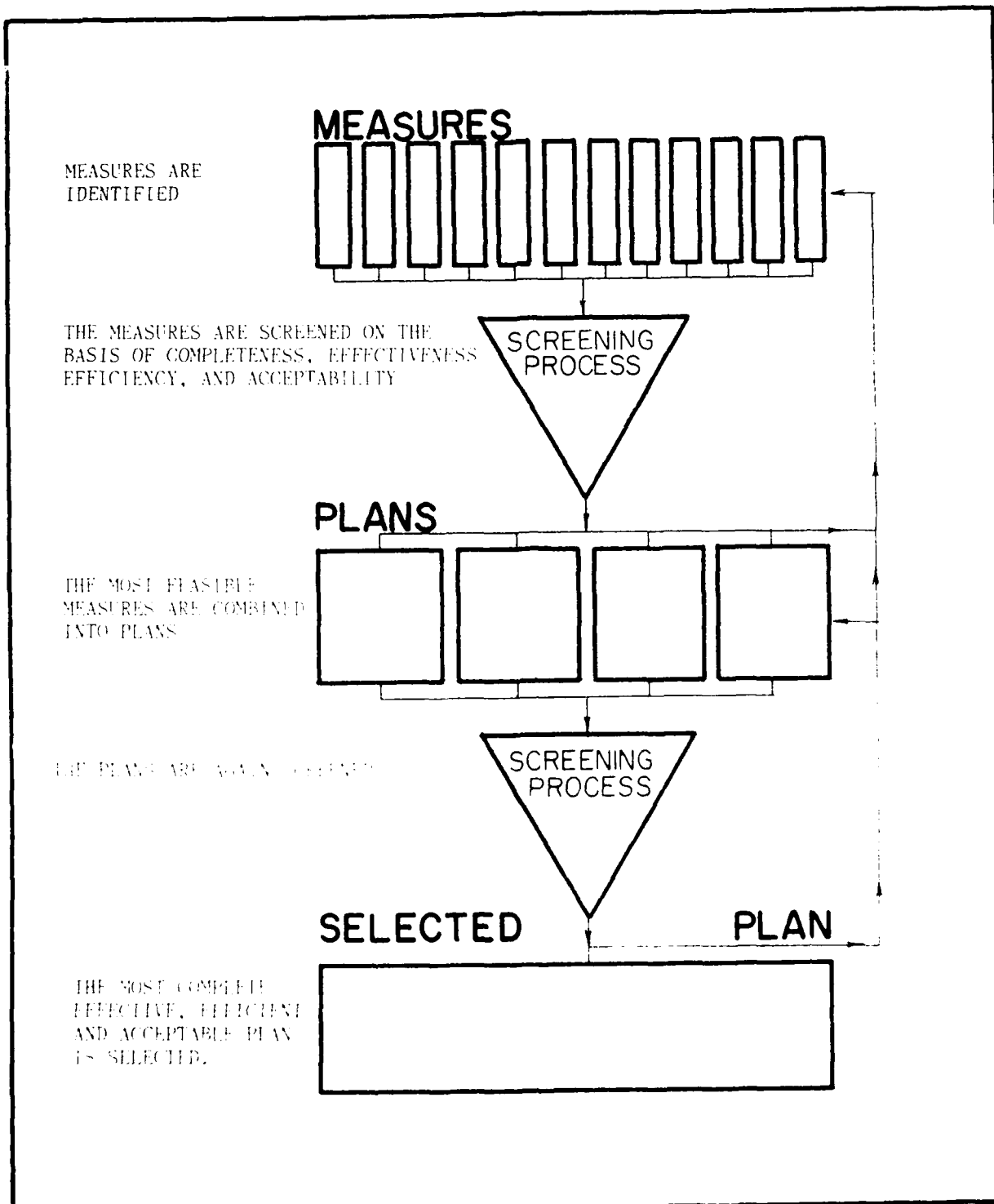


Figure 3
NOGALES WASH STUDY
PLAN SELECTION PROCESS

The planning process used in this study consists of six steps that identify or respond to problems and opportunities associated with the Federal objective and specific State and local concerns, and culminates in the selection of a recommended plan. The process involves an orderly and systematic approach to making determinations and decisions at each step so that the interested public and decision-makers in the planning organization can be fully aware of the basic assumptions employed, the data and information analyzed, the areas of risk and uncertainty, the reasons and rationales used, and the significant implications of each alternative plan. The following identifies those steps.

- Step 1: Specification of the Problems and Opportunities Associated with the Federal Objective and Specific State and Local Concerns.
- Step 2: Inventory and Forecast Water and Related Land Resource Conditions.
- Step 3: Formulation of Alternative Plans
- Step 4: Evaluation of Effects
- Step 5: Comparison of Alternative Plans
- Step 6: Plan Selection

The goal of this study is to identify and select a plan that will assist in solving water resource problems. During this investigation, many measures were developed to solve specific problems at specific locations. These measures were then screened on the basis of support from local interests, environmental and public acceptability, and economic feasibility. The most acceptable measures were combined into more comprehensive plans.

The plans were also screened on the above criteria before the selected plan(s) was identified. This process is iterative and as such, the steps were repeated many times throughout the study as new measures or new plans developed. Figure 3 illustrates this process.

E. THE REPORT

This feasibility report discusses the investigation which was conducted to develop a selected plan of improvement. The document is arranged into two major segments: the main report and the environmental assessment (EA). The Coordination Act Report of the U. S. Fish and Wildlife Service and other environmental information referenced in the EA are included in the appendices to the EA.

F. STUDY HISTORY

The Corps' investigation for flood control in the Nogales Wash Study Area was initiated in December 1977 after the SCCFCD's request to the International Boundary and Water Commission (IBWC) for a 5.5 mile extension of the existing flood control channel was turned down by IBWC. The Commission's reason was that the extension was entirely in the United States and suggested that SCCFCD contact the Corps of Engineers. That same month, the SCCFCD requested by letter that the Corps assist in developing and implementing a solution to flooding and erosion problems along the Nogales Wash.

In February 1978, the Los Angeles District Engineer (hereafter District Engineer) responded to SCCFCD and stated that the Corps has authority to construct emergency streambank protection works to protect "public" facilities, but that the majority of erosion damages along Nogales Wash were to private facilities. The Corps, therefore, had no authority to participate in solutions addressing erosion of private property. The District Engineer recommended that a flood plain management program be adopted in Santa Cruz County.

In December 1981, a meeting was held in Nogales between representatives of the Corps, the U. S. Section of the IBWC, Santa Cruz County and the City of Nogales to examine flooding in Nogales from waters originating in Mexico.

On June 10, 1982 SCCFCD formally requested that the Los Angeles District initiate a flood control study on Nogales Wash, and indicated its willingness to share in the cost of such an investigation. It was determined that a feasibility study of flood control on Nogales Wash could be undertaken by the Corps of Engineers as an interim report under the Gila River and Tributaries Authority.

In October 1983 the Los Angeles District Office (hereafter LADO) received funds to initiate the reconnaissance phase. The reconnaissance phase technical analysis was completed in September 1984 with a Fact Sheet that recommended continued study at the feasibility phase level. The feasibility study was initiated in April 1985 after the four objectives of the reconnaissance phase had been met and funds released.

G. STUDY PARTICIPANTS, COORDINATION AND PUBLIC INVOLVEMENT

Many agencies and groups at the Federal, State, County, City and local level participated in this study. They include:

* FEDERAL

- U.S. Section, International Boundary and Water Commission
- Department of Agriculture, Soil Conservation Service
- Department of Interior, Fish and Wildlife Service
- Department of Health and Human Services, Federal Emergency Management Agency
- Department of Agriculture, Forest Service (Coronado National Forest)
- Department of Treasury, Customs Service
- Department of Justice, Border Patrol
- General Services Administration
- Environmental Protection Agency
- Department of Agriculture, Agricultural Stabilization and Conservation Service
- Department of Justice, Immigration and Naturalization Service
- Department of Interior, Geological Survey
- Department of Transportation, Federal Highway Administration
- Department of Agriculture, Animal and Plant Health Inspection Service
- Department of Commerce, National Weather Service

- * STATE (Arizona Department of...)
 - Water Resources
 - Health Services
 - Transportation
 - Emergency Services
 - Game and Fish
 - Parks (Recreation)
 - Parks (State Historic Preservation Officer)
 - Public Safety
 - Commerce
 - Economic Security
 - Environmental Quality
 - State Land
- * COUNTY (Santa Cruz County...)
 - Flood Control District
 - Planning and Zoning
 - Parks and Recreation
 - Civil Defense
 - Sheriff
 - Public Works
 - Emergency Services
 - Engineering (Cella Barr Associates (Contractor))
- * CITY (Nogales City ...)
 - Parks and Recreation
 - International Wastewater Treatment Plant
 - Water
 - Planning and Zoning
 - Streets (Collins - Pina Consulting Engineers Inc. (Contractor))
 - Engineering (Collins - Pina Consulting Engineers Inc. (Contractor))
- * PRIVATE/QUASI-PUBLIC
 - Southern Pacific Railroad
 - Citizens Utilities Co.
 - West Mexico Vegetable Distributors Association
 - Housing Advisory Board
 - Nogales/Santa Cruz County Chamber of Commerce
 - U. S. Mexico Business Information Service

These agencies and groups provided numerous studies, documents and data dealing with water resources analysis, recreation, economics, land use and value, survey, and environmental resources for both the reconnaissance and feasibility phases. The U.S. Fish and Wildlife Service, prepared an independent "Coordination Act Report" analyzing the effects of various alternatives on the fish and wildlife community in the study area.

This study has incorporated a public involvement program which is consistent with Corps guidance and policy. Various public involvement activities were conducted to ensure that the study would be responsive to public views and preferences. Actively involved in coordination activities were other Federal, State, regional, and local governmental entities and officials; public and private organizations; and individuals. Santa Cruz County and the Corps

cosponsored a number of public meetings which were conducted in a "workshop" format.

In the reconnaissance phase, a workshop held in Nogales, Arizona, 18 July 1984, gave agencies and local interests an opportunity to express their views on the problems, possible flood control improvements, potential recreation developments, fish and wildlife resources, and related socioeconomic, ecological, and environmental problems and conditions in the study area. Approximately 200 people were in attendance.

At the initiation of the feasibility study, a presentation/workshop held in Nogales, Arizona, 25 September 1985, informed the public as to the results of the reconnaissance phase, what would be evaluated in the feasibility phase, and again, gave the public an opportunity to express their views. On this occasion, three separate workshops were held. The first was made to representatives of the various Federal, State and local government agencies and in part, was used as a scoping meeting. The other two meetings were to the general public. Again, approximately 200 people were in attendance at these workshops.

Throughout the study, periodic coordination meetings were held with the General Manager of the SCCFCD and the Santa Cruz County Board of Supervisors (hereafter SCCBS). The mayor of the City of Nogales or his representatives were often at these meetings.

Two local neighborhood committees from the Chula Vista/Pete Kitchen and the Firestone Garden neighborhoods took special interest in the study. The project manager (hereafter PM) and technical staff from LADO met several times with the committees or representatives of the committees to investigate their specific problems and needs.

From 20 November 1987 to 20 December 1987, the Draft Feasibility Report and Environmental Assessment was available for public review and comment. Responses to the draft report are included in APPENDIX A (PUBLIC RESPONSE TO DRAFT REPORT).

On 25 January 1988, the District Engineer, Los Angeles District, presented the results of the Nogales Wash and Tributaries Study to the Santa Cruz County Board of Supervisors at a public meeting in Nogales, Arizona. After the presentation, the Supervisors opened the meeting to public comment and questions. In general, the comments were supportive of the Recommended Plan. A land owner and two representatives from the City of Nogales, that the proposed project was too small and did not provide flood control in the Valle Verde community, and north to Chula Vista. It was explained that these potential solutions were eliminated as a result of not being economically justified.

H. PRIOR STUDIES AND REPORTS

The prior studies and reports summarized here were conducted and prepared by the Corps of Engineers and other agencies, and were incorporated, as appropriate, into the study.

On January 7, 1932, Senate Document No. 44, "Flood Control at Nogales Arizona - Mexico", was provided to Senator Carl Hayden of Arizona. This document transmitted a report prepared by the International Boundary and Water Commission (IBWC) which concluded that the flood situation was serious and demanded an immediate solution. The report recommended that the two governments (U.S. and Mexico) complete final studies, plans, and cost estimates for a flood control project. This report led to the construction of a flood control channel system built by the IBWC in the 1930s and 1940s.

In September 1978, the Corps prepared "6-10 October 1977, Flood Damage Report on Storms and Floods on Santa Cruz, Gila and San Pedro Rivers, Arizona". This report includes hydrologic and economic data pertaining to the Nogales Wash Study area.

The Federal Emergency Management Agency (hereafter, FEMA) completed a Flood Insurance Study for the City of Nogales in October 1980. As part of this flood insurance study flow areas for the 500-year and 100-year floods were developed for Nogales Wash and several of its main tributaries. The topographic information developed for the Flood Insurance Study (FIS) was used for the Corps' Reconnaissance Report. FEMA also completed a Flood Insurance Study for Santa Cruz County in February, 1980.

Ephraim Canyon Wash is a major tributary of the Nogales Wash basin (see Plate 1 for location). Since 1958 it has been studied by both the Corps and the Arizona Department of Water Resources (ADWR). Although it was determined in 1985 that flood control on this tributary is not in the Federal interest (not economically justified), a number of technical reports by the Corps and ADWR did provide some data relevant to this report.

ADWR also prepared "Preliminary Project Evaluation, Potrero Creek Flood Control Project, Santa Cruz County Arizona", in July 1983 which addressed flooding and potential solutions in the Chula Vista - Pete Kitchen area (see Figure 2 for location).

I. COMPLETED WATER RESOURCES PROJECTS

The following completed water resources projects are identified for information purposes only and do not necessarily relate to the proposed project described in the following chapters. Figure 4 illustrates the completed water resources projects in the study area. The IBWC constructed approximately 3.1 linear miles of covered channel and 1.3 linear miles of open channel for flood control purposes in the Cities of Nogales, Arizona and Nogales, Sonora, Mexico (Figure 4). These channels were constructed in the 1930's and 1940's. A detailed description of these channels is provided in chapters 2 and 3.

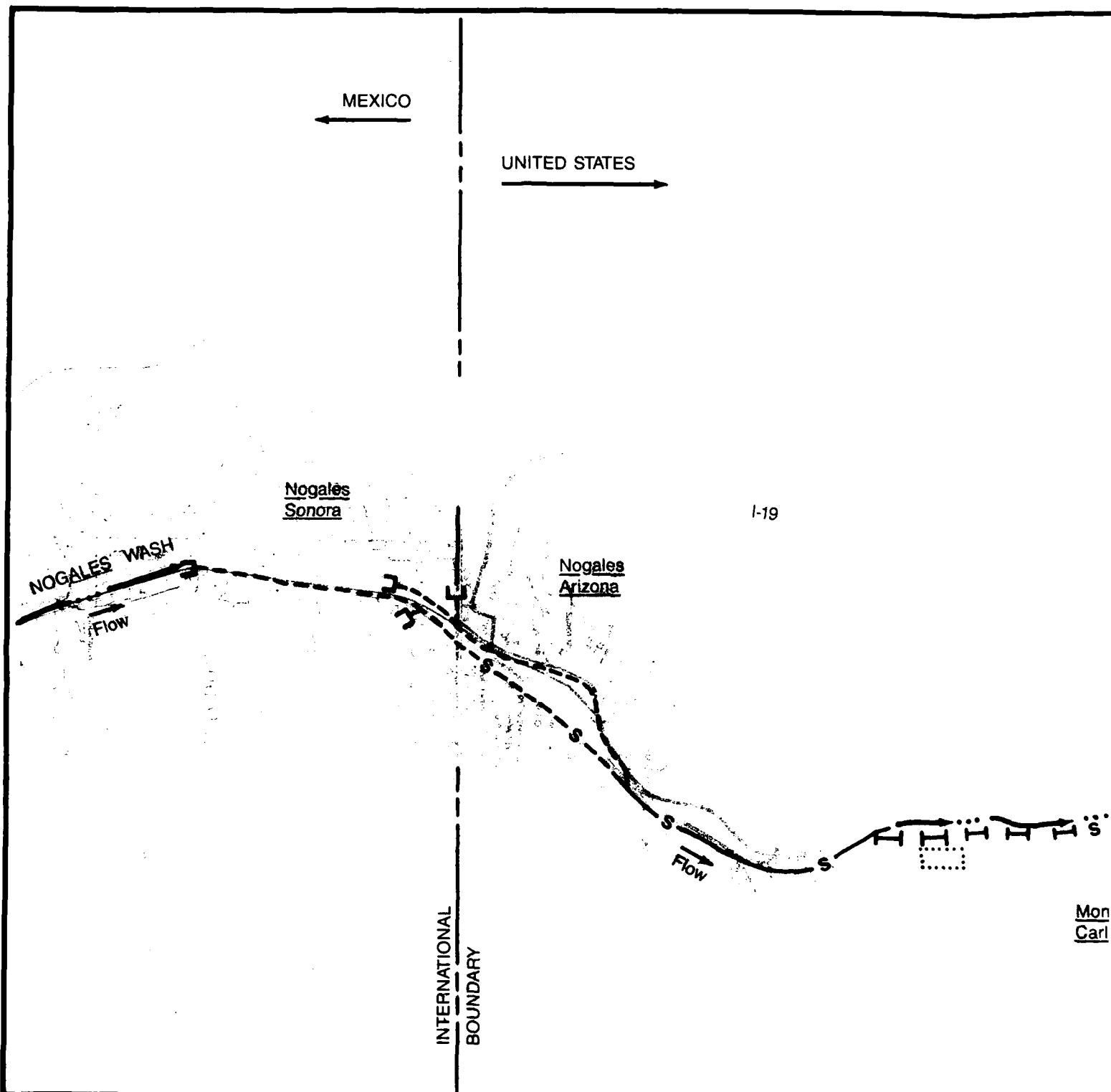
In 1951, the IBWC constructed an International Waste Water Treatment Plant approximately 1.5 miles north of the border. By the mid 1960's, however, this

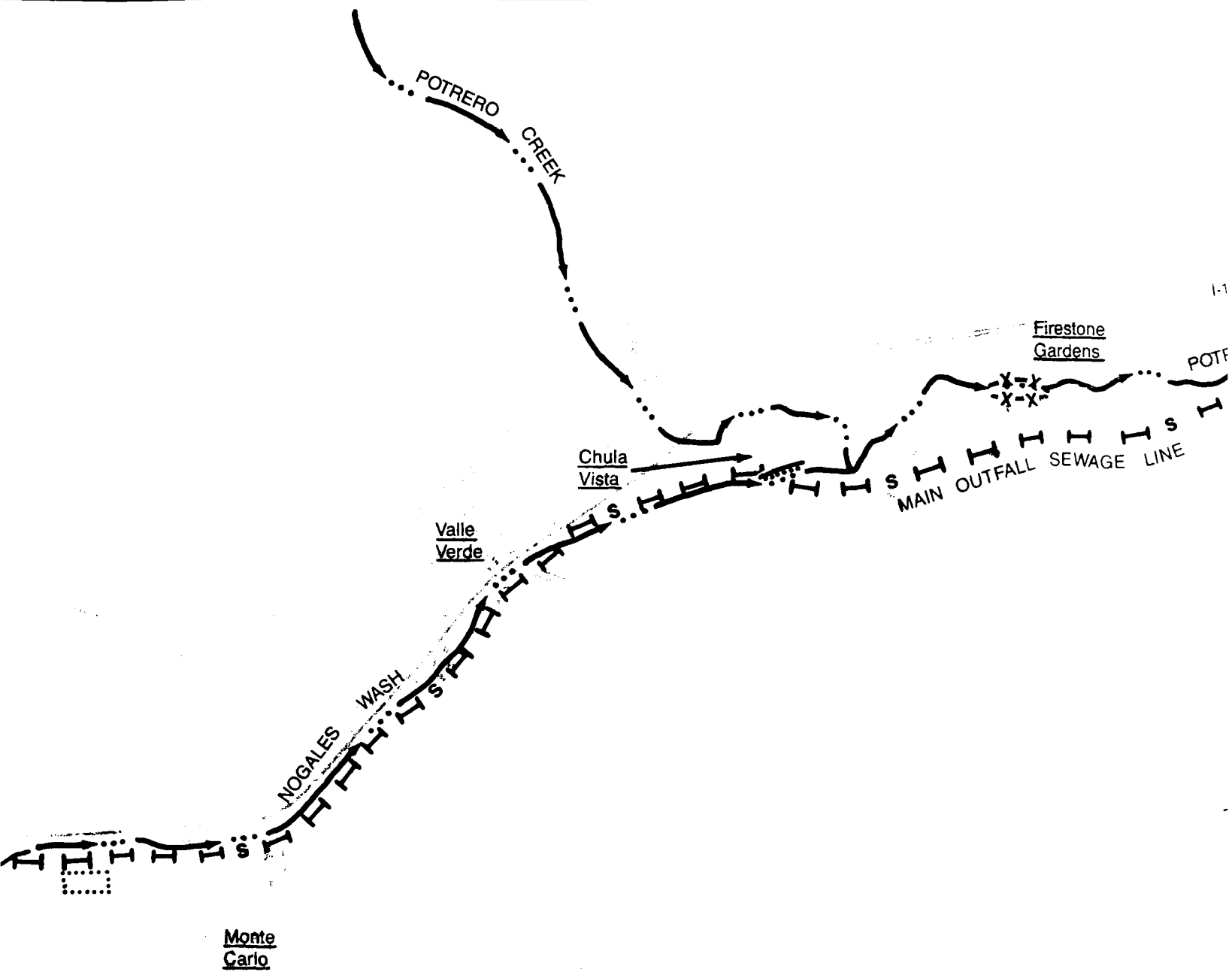
facility was no longer adequate and a new facility was constructed at the confluence of Potrero Creek and Santa Cruz River.

Santa Cruz County constructed approximately 450 linear feet of soil cement and gabion bank protection on the west bank of Nogales Wash adjacent to Chula Vista in 1985.

The Soil Conservation Service (hereafter SCS) placed approximately 350 linear feet of Kellner jacks on the west bank of Nogales Wash adjacent to the Firestone Gardens community in 1985. In 1987 the SCS constructed an additional 625 linear feet immediately across on the east bank.

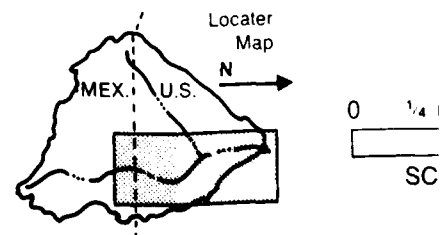
A recreation reservoir was created on Chimeneas Arroyo approximately 3.8 miles south of the International Boundary (circa 1931). The drainage area controlled by the dam is approximately 4.0 square miles (see Plate 1).

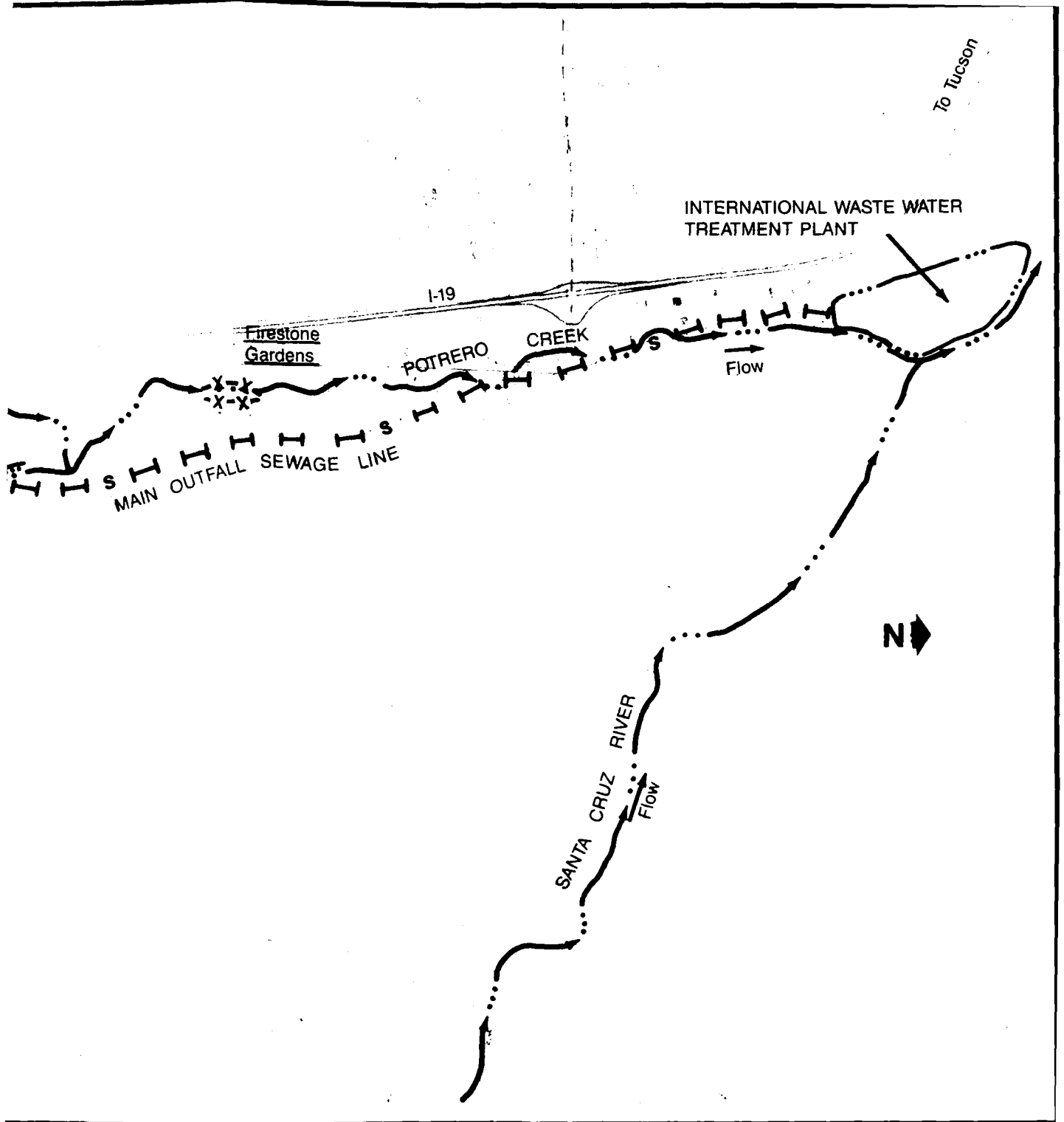




SEWER LINE
 BOUNDARY
 SEWAGE TREATMENT PLANT
 EMBANKMENT
 LINES

... → MAIN WATER COURSES





CHAPTER II

RESOURCES AND ECONOMY OF THE STUDY AREA

A. LOCATION AND BOUNDARIES

The Nogales Wash Study Area is located on both sides of the United States/Mexico International Boundary, approximately 60 miles south of Tucson, Arizona. The northern portion of the study area is in or near the City of Nogales, Santa Cruz County, Arizona. The southern portion of the study area is in the State of Sonora, Republic of Mexico and contains the sister city, also named Nogales (see Figures 1 & 2).

The study area is in itself the Nogales Wash/Potrero Creek drainage basin above the confluence of Potrero Creek and the Santa Cruz River. Below the confluence of Nogales Wash and Potrero Creek, the mainstem is named Potrero Creek, however, for this report, the drainage basin/study area will be referred to as the Nogales Wash drainage basin/Nogales Wash study area. The term "Nogales Wash/Potrero Creek mainstem " will refer to Nogales Wash above the confluence with Potrero Creek, and Potrero Creek from its confluence with Nogales Wash to the confluence with the Santa Cruz River. The portion of Potrero Creek above the confluence with Nogales Wash is not considered a part of the mainstem.

The study area is approximately 15 miles long, 10 miles wide and has an area of approximately 94.6 square miles. Approximately 48% of the drainage area is in Mexico.

B. PHYSICAL CHARACTERISTICS

1. General Description And Topography

The study area is located in the Mexican Highland subprovince of the Basin and Range geomorphic province of south-central Arizona. This region is characterized by numerous low, rugged mountain ranges separated by deep alluvial valleys. Nogales Wash and Potrero Creek occupy one such valley in the west side of the upper Santa Cruz drainage basin. The Santa Cruz basin extends southward into Mexico and is the major hydrographic feature of the region. Nogales Wash originates 7 miles south of the United States/Mexico International Boundary and flows north through Nogales, Sonora and Nogales, Arizona, joining Potrero Creek approximately 4.8 miles north of the border. In the study area, Nogales Wash and Potrero Creek consist of meandering channels incised 5 to 25 feet deep in the flood plain of an alluvium filled valley. The average width of the valley floor is about 1/2 mile. Elongated ridges and canyons stretch southwestward into the Pajarito Mountains, while the wash and creek are separated from the Santa Cruz River to the east by a low, 5-mile wide range of mountains. Local elevations vary from about 3500 feet above sea level along Potrero Creek to greater than 4800 feet in the surrounding mountains.

2. Geology

The study area lies in a terrain of Tertiary sedimentary and Mesozoic intrusive rocks, broken by late Tertiary normal faults. In general, the Tertiary sediments overlie the Mesozoic rock, however, due to uplift along the faults, several vertical contacts occur. Canyons and valleys are filled with Older and Recent alluviums, while Older alluvium mantles the bedrock along their margins. Both units may be several hundred feet thick.

There are four geologic units exposed in the study area. They are Recent (Quaternary) alluvium, Older (Quaternary - Tertiary) alluvium, Tertiary Nogales Formation, and Jurassic Mount Benedict Quartz Monzonite. The Nogales Wash/Potrero Creek mainstem is directly underlain by the Recent alluvium. The Nogales formation is also exposed intermittently in the streambed.

3. Regional Seismicity And Faulting

The numerous faults in the immediate project area are of Tertiary age and are no longer active. The nearest known active fault is the Patagonia Mountain fault, 10 miles northeast of Nogales. This fault may be considered capable of a magnitude 5.4 earthquake which could produce a peak horizontal ground acceleration of 0.13g at the project (Corps of Engineers, SPD, 1979). The greatest historical earthquake in the region was an 1887 Richter magnitude 7.2 event centered approximately 110 miles southeast of the study area in Sonora, Mexico, near the Arizona border. In 1916, an earthquake occurred in the immediate Nogales vicinity, with an estimated epicentral intensity of VI. Accelerations during both of these events would have been about 0.09g (Corps of Engineers, SPD, 1979).

4. Soils And Foundations

Generally there are three soil associations in the study area (Soil Conservation Service and Forest Service in cooperation with Arizona Agricultural Experiment Station, April 1979). They are: Comoro-Pima, Caralampi-White-House-Hathaway, and Lampshire-Chirachua-Graham.

The soils in the Nogales Wash Study area are primarily shallow and rocky, with rocks of andesite and rhyolite tuffs, granites and small areas of clay shales. The steeper slopes expose numerous rock outcroppings and shallow loamy soils. Shallow loamy soils with thin clay sub-soils are located on the gentler slopes. Rock outcrops constitute twenty-five (25) percent or less of the study area.

5. Air Quality

Nogales, including the study area, is considered an attainment area. Although it does exceed the particulate standard, it is still considered an attainment area because it falls under the EPA rural fugitive dust policy which states that in western states, those areas with no industrial facilities and populations of 50,000 to 100,000 would be considered as attainment areas (Arizona Department of Health Services). The particulate problem is probably due to the nearness to Nogales, Sonora, which has unpaved roads and where wood burning is allowed and common.

C. WATER RESOURCES AND CHARACTERISTICS

1. Climate

The climate of the study area (southern Arizona) is described as semi-arid high desert. The mean maximum/minimum temperatures in January are about 64/27 degrees Fahrenheit, while the same figures for July are 93/64 degrees Fahrenheit. The extreme high and low temperatures expected for the basin would be about 106 and -3 degrees Fahrenheit. Mean monthly precipitation over the drainage basin ranges from about 0.12" in May to 4.68" in July. About 50 percent of the 16.6 inch mean annual precipitation falls during the months of July, August and September, mostly as a result of heavy local summer thunderstorms, although tropical storms may form off the west coast of Mexico to produce heavy general and local precipitation. Much of the remaining precipitation falls as the result of general winter-type storms. The driest months of the year are May and June. Winds in the region are generally moderate, with light breezes prevailing from the south. Gusts of up to 70 miles per hour have been recorded during heavy thunderstorms.

2. Surface Hydrology

Subbasins within the Nogales Wash drainage basin (Plate 1), can be classified as either desert valley or desert mountain, depending on their proximity to Nogales Wash and Potrero Creek. Stream gradients range from about 270 feet per mile in the headwaters of the upper canyons to about 100 feet per mile in the valley regions.

a. Existing water courses

Perennial streamflow in Nogales Wash originates in the hills of Sonora, Mexico and flows towards the north across the International Boundary into the United States. Dry weather flows in the stream bed range from 2 to 20 cubic feet per second.

Major tributaries to the mainstem (see Plate 1) originate in the Pajarito Mountains west of Nogales. They include Cemetery Wash, Ephraim Canyon Wash, Mariposa Canyon Wash, Potrero Creek, and Alamo and Pesquiera Canyon Washes. Streamflow in all major tributaries is ephemeral, occurring only during and immediately following heavy precipitation.

For plan formulation purposes, the Nogales Wash/Potrero Creek mainstem was broken up into five reaches, based upon existing channel features, community development, and the local sponsors desire to implement specific flood control and related features. The following is a description of the reaches and their existing characteristics. Plate 2 illustrates the reaches. Tables 1,2 and 3 identify the reach lengths, and Figure 4 illustrates the completed water resources projects in the various reaches.

The following description of water courses provides estimates of existing channel capacities. Provided with these estimates are the present and future flood frequencies associated with these capacities. The difference between the two frequencies (present and future) reflects the anticipated change (increase) in runoff as future urbanization takes place. For example, at some

Table 1. Lengths of Reaches

(Nogales Wash-Potrero Creek Mainstream)

Reach/ Subreach	Length (River Miles)	
1 - Upstream Section	6.4	
2 - Covered Concrete Channel Section	2.1	
2B (Mexico)		1.2
2A (USA)		0.9
3 - Open Concrete Channel Section	1.2	
4 - Unimproved Section	5.5	
4B (Upstream of Chula Vista)		3.2
4A (Downstream of Chula Vista)		2.2
5 - Downstream Section	2.0	
TOTAL	17.7	

Table 2. Lengths of IBWC Covered Channels

(Nogales Wash and Arroyo Boulevard Covered Channels)

Covered Channel	Length (Linear Miles)		
	Mexico	USA	Total
Nogales Wash	1.2	0.9	2.1
Arroyo Boulevard	0.1	0.9	1.0
TOTAL	1.3	1.8	3.1

Table 3. Lengths of IBWC Open Channels

(Nogales Wash and Arroyo Boulevard Open Channels)

Open Channel	Length (Linear Miles)		
	Mexico	USA	Total
	0.0	1.2	1.2
	0.0	0.1	0.1
Nogales Wash	0.0	0.1	0.1
Arroyo Boulevard	0.0	1.3	1.3
Total	0.0	1.3	1.3

hypothetical point along a wash, the channel may carry or contain a flow of 1000 cubic feet per second (cfs) which may be the flow resulting from a 20-year flood. As the drainage basin becomes more urbanized in the future, the amount of storm runoff would increase. As a result, under future conditions, perhaps a 15-year flood would produce the same (1000 cfs) discharge that could be carried by the existing or "without project" channel. The channel capacity has not changed; only the flood frequency associated with it.

REACH 1 (Upstream Section)

The headwaters of Nogales Wash originate approximately seven miles south of the border. Dry weather flow is fed by springs, however, some sewage contributes to the flow in the wash through Nogales, Sonora. Upstream portions of this reach flow naturally, while downstream portions have been straightened and in some cases lined with grouted stone. The capacity of this reach varies from less than 100 cfs to approximately 4000 cfs (13-year present condition, 10-year future condition).

REACH 2 (Covered Concrete Channel Section)

Approximately one mile south of the border, Nogales Wash enters a covered channel at the "main inlet" (Figure 5). This channel, called the Nogales Wash Covered Channel (NWCC), is a rectangular reinforced concrete box measuring 22 feet wide by 12 feet high. It has a capacity of approximately 4900 cfs (16-year present condition, 11-year future condition) with two feet of freeboard.

The main inlet to the NWCC drains approximately 24.4 square miles in Mexico (see Figure 6). Due to the physical surrounding, this structure has an inlet capacity of 4200 cfs (approximately 700 cfs less than the covered channel itself). Inflow to the Nogales Wash Covered Channel also occurs at the "Calle Buenos Aires inlet", located approximately 600 feet south of the border. This inlet drains about 0.6 square miles and can accommodate the Corps' estimated 100-year runoff (see Figures 5 and 6).

The outlet from the Nogales Wash Covered Channel is located approximately 0.9 miles north of the border near its confluence with the Arroyo Boulevard Covered Channel (ABCC). The ABCC is a similar conduit draining the metropolitan area of Nogales, Sonora (Figure 5). This reinforced concrete channel measures 23 feet by 8 feet and has a capacity of approximately 2750 cfs. The ABCC has two inlets. The "south" inlet (approximately 80% of this inlet is currently plugged by silt and debris) is located beneath an old hotel situated approximately 1400 feet south of the International Border (Figure 5). This inlet was designed to collect local runoff and overland flow which may have been missed by the main inlet (Figure 6), however, recent urbanization has made this inlet ineffective. A second inlet, or the "west" inlet to the ABCC, is located adjacent to the International Boundary approximately 550 feet west of the United States/Mexico Border Station on Grand Avenue (Figure 5). Overland flow from areas upstream of the west inlet (see Figure 6) are restricted from entering by its invert and by an approach wall which channels local subarea runoff. Thus excess overland flows drain to the International Border at the center of the valley. This point will be referred to as Concentration Point (C.P.)4. Rating curves were developed for each of the inlets to estimate the amount of channel and overland flow. Tables 4-7 list the computed inlet rating

curves. The length of Reach 2 is approximately 2.1 linear miles; however, because of the parallel system, it contains a total of approximately 3.1 river miles of covered channel.

Reach 3 (Open Concrete Channel Section)

Approximately 0.8 miles north of the border, both covered channels open to form two open concrete channels (Figure 5). Several hundred feet further north, the two open channels converge to form a single channel approximately 1.1 river miles in length. This channel, called the Nogales Wash Open Channel, has a capacity varying from 8700 to 12,000 cfs (30 to 60 year present condition, 25 to 50-year future condition).

Reach 4B (Unimproved Section-Upstream of Chula Vista)

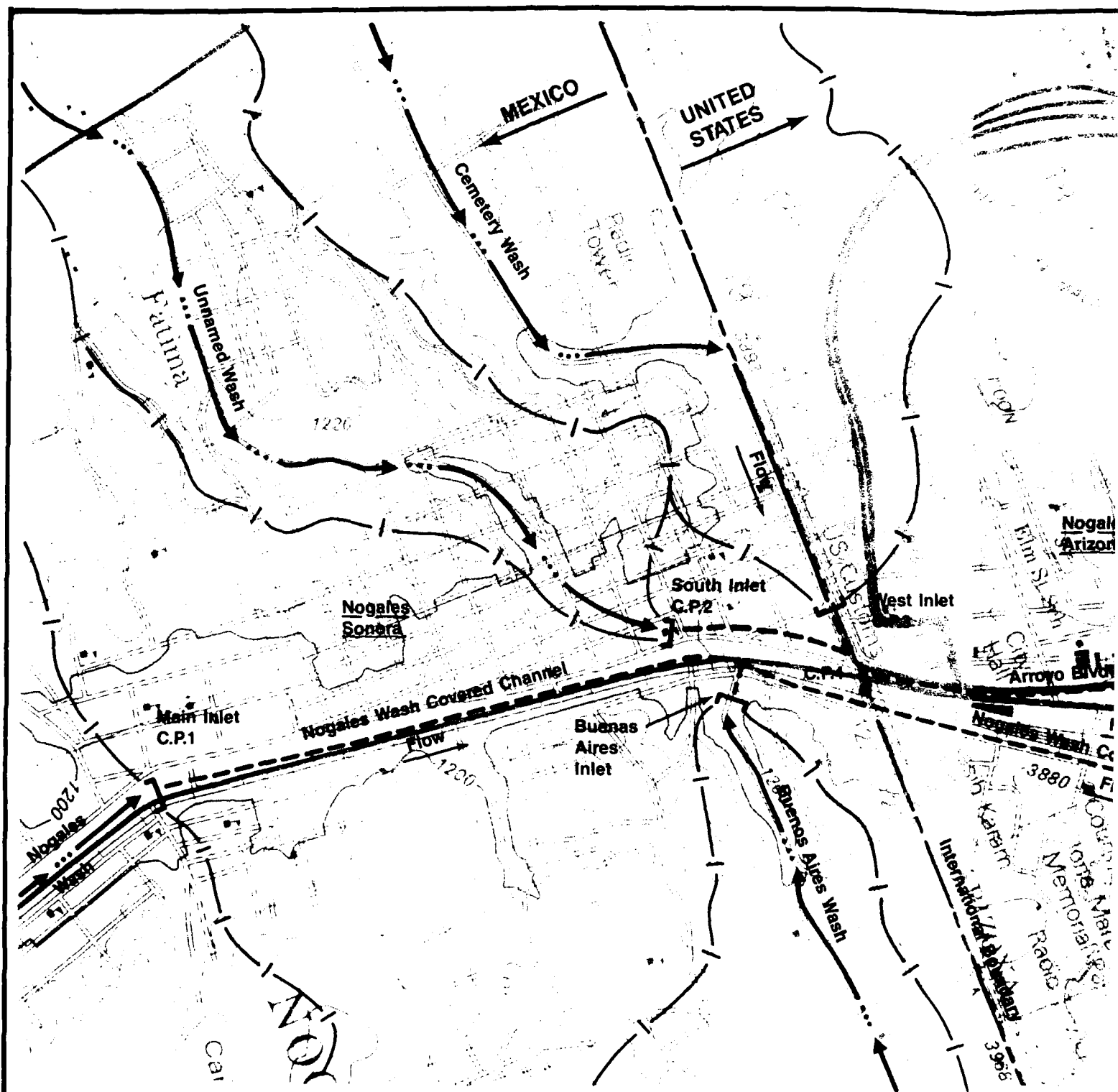
In this 3.2 mile reach, the stream valley is less than 1/4 mile wide except near the mouths of Mariposa and Potrero Canyons. In the lower two-thirds of this section, the streambed follows the extreme east side of the valley where, for about 0.8 river miles, it is restricted to a narrow space between the railroad embankment and either Old Tucson Road or commercial establishments. Bank heights vary from 5 feet at the upstream end of this reach to 15 feet upstream of the Chula Vista. The streambed width varies from 15 to 50 feet and channel capacity varies between 2000 and 4000 cfs (12 1/2 to 50-year future condition).

Nogales Formation bedrock is exposed along the channel at several locations. It is likely that bedrock lies close to streambed elevation throughout this reach. Much of the bank material in reach 4b is highly erodible and various bank protection methods have been utilized, including reinforced concrete, pipe and wire, sheet piles, and armoring with stone and concrete rubble. Many portions have failed due to undercutting, erosion around the ends of the structures, and from flows getting behind the bank protection. This reach is crossed by five bridges of various conditions and capacities. It ends at a sharp bend where Nogales Wash turns and dips under the Old Tucson-Nogales Highway bridge just east of the Chula Vista subdivision.

Reach 4A (Unimproved Section-Downstream of Chula Vista) and Reach 5 (Downstream Section)

The two final reaches of the study area are very similar in character and will be described together. These reaches are approximately 2.1 river miles in length and are primarily unimproved. To a large extent, the channel retains its natural alignment. The stream valley widens to approximately 1/2 mile after Nogales Wash joins Potrero Creek, and the channel meanders generally in the central portion of the valley to the end of the reach. Bank heights vary between 10 and 20 feet and the streambed width varies from approximately 10 feet in the center of the valley to less than 50 feet at the downstream end of the reach. Flow entering from Potrero Creek is channelized through the Pete Kitchen mobile home subdivision; the capacity of this channel is limited to less than 300 cfs. Reach 5 ends at the confluence with the Santa Cruz River.

Reach 4A is particularly susceptible to bank erosion based on experiences in previous floods. Single storms have resulted in as much as 80 feet of lateral bank erosion. Where subject to active erosion, the stream banks stand vertical



LEGEND

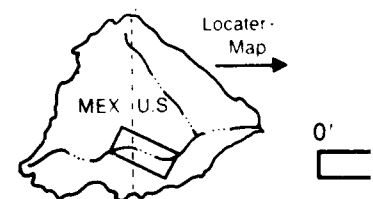
- |— Subarea Boundary
- International Boundary

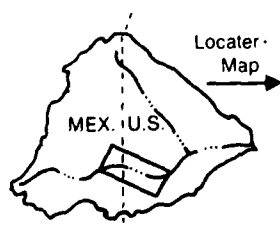
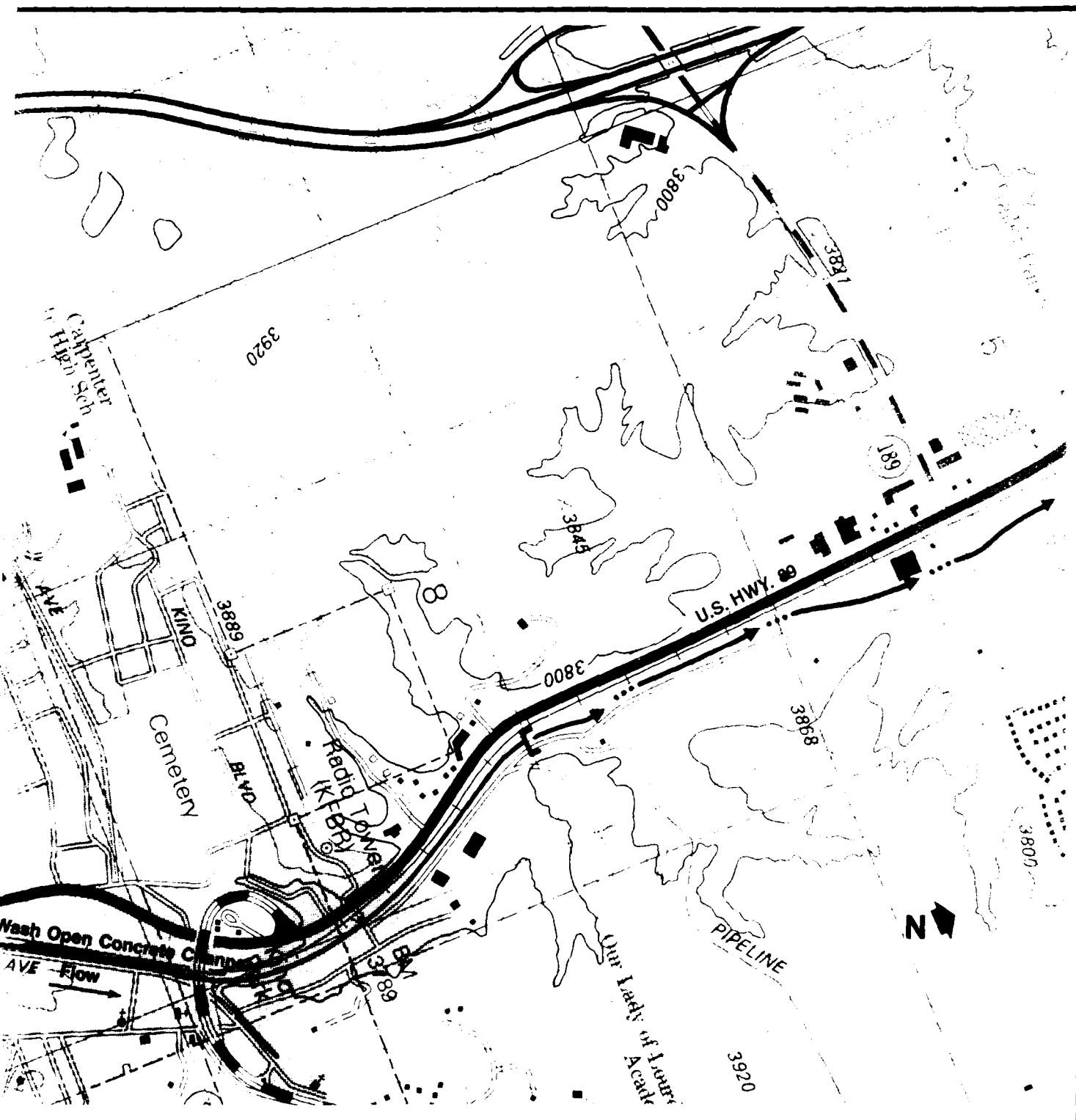
- Covered Concrete Channel
- Open Concrete Channel
- > Channel Flow Upstream of Inlets and Downstream of Open Concrete Channel
- Channel Inlets
- [--- Channel Outlets

CP# Concentration Point



Concentration Point





0' 500' 1000' 2000'

Scale 1" = 1000 ft.

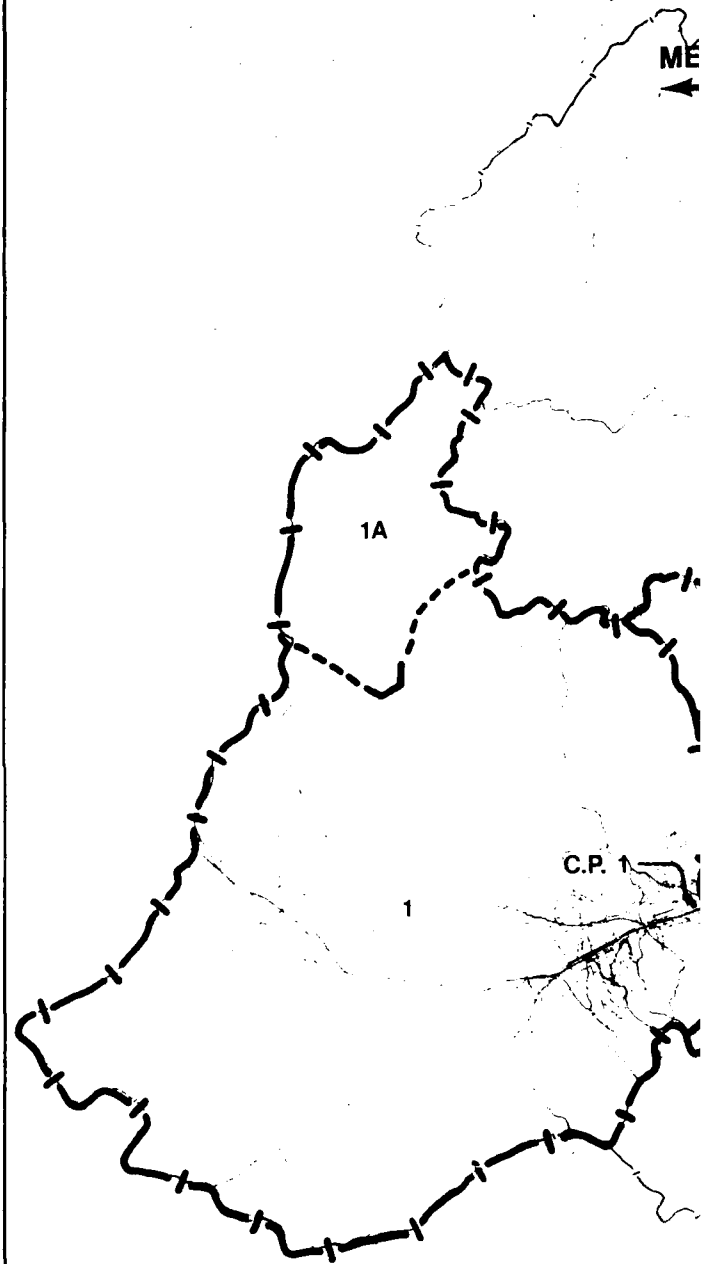
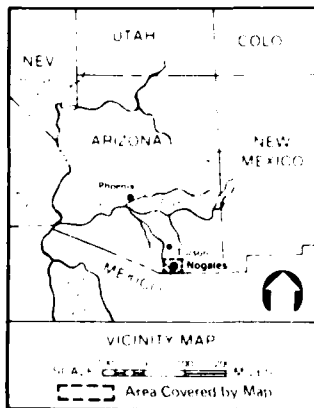
Figure 5
Nogales Wash
Existing Flood Control
Channel System

LEGEND

 Subarea Boundary
 International Boundary

Sub Area	Description	Area (Sq. Miles)
1	Contribution to Main Inlet at C.P.1	24.4
1A	Portion of Subarea 1 Controlled by Les Chimeneas Dam	
2	Contribution to South Inlet at C.P.2	0.5
3	Contribution to West Inlet at C.P.3	1.7
B.A.	Contribution to Buenos Aires Inlet (No C.P. Designation)	0.6
I.D.	Interior Drainage Between Inlets and International Boundary at C.P.4	0.8
Total Potential Contribution at International Boundary (C.P.4)		28.0

CP# Concentration Point



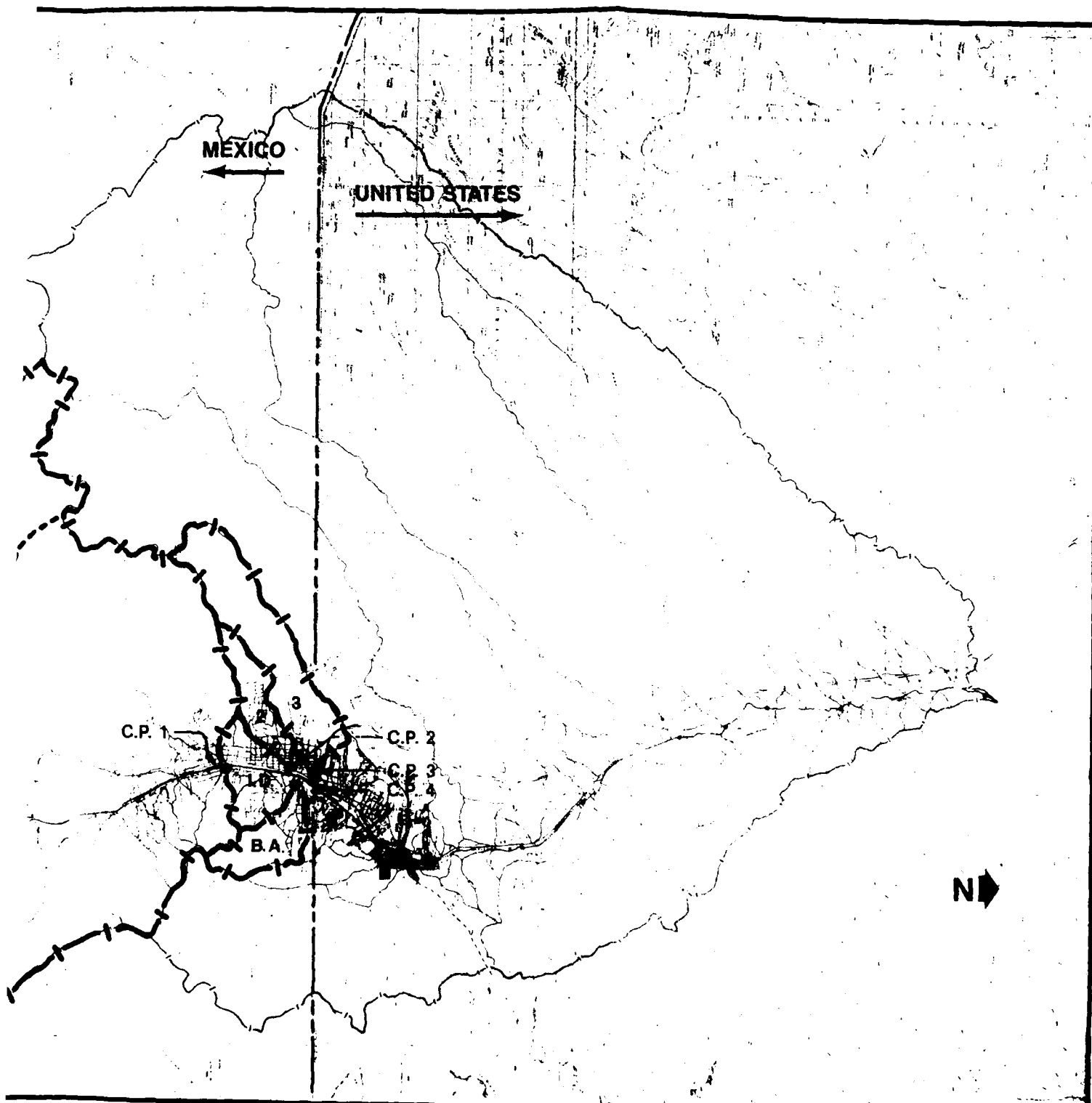


Figure 6
Nogales Wash
Subbasin Contribution To
Existing Covered Channel
System

0' 4000' 8000' 16000'
Scale: 1" = 8,000:0"

Table 4. Rating Curve at Concentration Point 1
(Main Inlet at Nogales Wash Covered Channel)

W.S.E.L. (Local Datum-ft)	Channel (cfs)	Overland (cfs)	Total (cfs)
0	0	0	0
5	500	0	500
10	1600	0	1600
15	3200	0	3200
18.5	4100	0	4100
19.3	4200	500	4700
20	4380	1520	5900
21	4550	3450	8000
22	4750	6150	10,900
23	4900	10,600	15,500
24	5100	15,900	21,000
25	5210	22,390	27,600
26	5400	28,900	34,300
27	5580	36,420	42,000
28	5700	44,000	49,700

Table 5. Rating Curve at Calle Buenos Aires
(Side Inlet to Nogales Wash Covered Channel)

W.S.E.L. (Local Datum-ft)	Channel (cfs)	Overland (cfs)	Total (cfs)
0	0	0	0
4	200	0	200
8	600	0	600
10.4	860	0	860
11	910	60	970
11.5	955	125	1080
12.0	992	248	1240
12.5	1032	528	1560

Table 6. Rating Curve at Concentration Point 2
(South Inlet to Arroyo Boulevard Covered Channel)

W.S.E.L. (Local Datum-ft)	Channel (cfs)	Overland (cfs)	Total (cfs)
0	0	0	0
1.2	100	0	100
1.8	133	64	197
2.8	185	65	250
3.8	225	75	300
4.8	264	86	350
5.8	297	103	400
6.8	330	175	505
7.8	355	545	900
8.8	380	920	1300
9.8	404	1596	2000

Table 7. Rating Curve at Concentration Point 3
(West Inlet to Arroyo Boulevard Covered Channel)

W.S.E.L. (Local Datum-ft)	Channel (cfs)	Overland (cfs)	Total (cfs)
0	0	0	0
2	100	0	100
4	295	0	295
6	570	0	570
8.2	775	0	775
8.5	800	50	850
9.0	824	226	1050
9.5	874	526	1400
10.0	900	1260	2160
10.5	940	2310	3250



"The Twin Cities of Nogales". An aerial view from Mexico looking at the International Boundary and north into Nogales, Arizona. The dashed line on the right illustrates the Nogales Wash Covered Channel. The one on the left is Arroyo Boulevard covered channel. Photo compliments of Petley Studios, Inc. Phoenix, Arizona.



"The main inlet to the Nogales Wash Covered Channel in Mexico." At the time of this picture (1984), the local Sonoran Government was lining the channel with grouted stone.



"The outlet to the Nogales Wash Covered Channel."



"The open concrete channel section", looking north from the outlet. Arroyo Boulevard channel joins from the left.



"The open concrete channel section", and another side tributary viewed from the Patagonia Road overpass.

to a height of 10 to 20 feet with some sloughing as the materials dry out. Reach 4A contains several erosion control features as mentioned in Chapter 1, paragraph I (see Figure 2). There are two highway bridge crossings of the mainstream in Reach 4A; there is one in Reach 5.

Existing Storage Structures

The Nogales Wash/Potrero Creek study area contains several local structures which provide limited storage in times of flood. The first is Las Chimeneas Dam located in Mexico on the La Granja Arroyo (Plate 1). It controls a drainage area of 4.0 square miles and has no outlet structure, however, there exists a detached spillway approximately 100 feet in width. This emergency spillway begins to pass flow after an accumulation of 700 acre-feet of storage. The IBWC Mexican Section, has estimated the total storage capacity of the reservoir at 1459 acre-feet at the top of the dam.

There are three other locations where significant storage may accumulate; all occur along the embankments of highways that intersect Nogales Wash tributaries. The Ephraim Canyon tributary is constricted by two highway embankments, AZ-189 and I-19. The last considered storage location occurs along Mex-15 at Cemetery Wash.

b. Water quality

A description of the existing surface water quality is contained within the attached Environmental Assessment.

3. Ground Water Hydrology

High groundwater levels may be expected along the mainstem year-round, where the groundwater table lies at the streambed level. Seasonal fluctuations generally are less than 3 feet. Groundwater baseflow is not considered a factor in contributing to flood flow.

a. Water supply

A description of the existing water supply is contained within the attached Environmental Assessment.

b. Groundwater quality

A description of the existing groundwater quality is contained within the attached Environmental Assessment.

c. Subsidence

There are no known occurrences of subsidence in the project area. Ground subsidence generally occurs due to a major groundwater level decline within a deep alluvial section. Although alluvium may be as thick as 200 feet in the center of the Nogales Wash-Potrero Creek valley, recharge appears to be ample, and there is no evidence of subsidence due to overpumping in the U.S. portion of the drainage basin.

D. BIOLOGIC RESOURCES AND CHARACTERISTICS

1. Vegetation

In general, the study area lies in the Chihuahuan Semidesert Grassland subresource area of the Southeastern Arizona Basin and Range resource area (Soil Conservation Service, 1985) In this subresource area, potential plant communities are mainly grasslands.

Along the Nogales Wash-Potrero Creek mainstem the vegetative community is characterized as riparian woodlands. The U.S. Fish and Wildlife Service has determined that the riparian habitat in the project area qualify for status as "Resource Category 2". This means that the habitat is of high value and is relatively scarce or becoming scarce on a national basis or in the ecoregion section. Additional information on this subject may be found in the attached Environmental Assessment (EA).

2. Fish And Wildlife

Wildlife values of the project area are closely associated with the riparian zone. The cover, water, and food resources afforded by this habitat attract wildlife from the adjacent grasslands as well as obligate riparian species. Bird surveys conducted in and near the study area have identified as many as 87 bird species which utilize the riparian deciduous woodlands. Other wildlife expected to utilize the riparian zone would include coyote, raccoon, coatimundi, striped and hooded skunk, wood rat, desert pocket mouse, round tailed ground squirrel, Sonoran mud turtle, tree lizard, and Couch's spadefoot toad. Small schools of fish, believed to be long fin dace have been observed by USFWS personnel at several locations. Several special status fish species have been found in the vicinity, however, none have been collected at Nogales Wash.

3. Special Status Species

No federally listed threatened or endangered species occur in the project area, although it is possible that peregrine falcons and bald eagles may use the area during winter migrations. The Beardless Cinch Weed and Western Yellow-Billed Cuckoo are reported from the Nogales Wash area and are federally listed as Category 2 candidate species (category 2 candidate species are those that have been published in a Notice of Review in the Federal Register, but for which the U.S. Fish and Wildlife Service does not have sufficient information at this time to support their being listed as threatened or endangered). The attached environmental assessment provides more detailed information on the species in section 6.1.c.

E. HUMAN RESOURCES AND CHARACTERISTICS

1. History And Culture

The Nogales vicinity is rich in cultural history. Various cultures of prehistoric Indians inhabited the vicinity until approximately A.D. 1450 when for uncertain reasons, these cultural sequences stopped. In A.D. 1691 Spanish

explorers entered the area and found Pima and Sobaipuri Indians farming along the stream and river banks. In 1701 Jesuit priests established a mission at Guevavi (located 2 miles northeast of the study area on the Santa Cruz River) and maintained that presence until approximately 1767 when the Franciscans took control of the missions along the Santa Cruz River and shifted their efforts to the north. The shift was in part, due to frequent raids made by Apache Indians. As a result, the vicinity was abandoned for approximately 100 years although it continued to serve as a trade route with Sonora.

In the 1860's Pete Kitchen became the first rancher in the area. Pete, his wife, and approximately 32 others were the only ranchers able to withstand the full brunt of the worst years of the Apache wars. In 1865 the army constructed a post, Fort Mason, at the mouth of Potrero Creek, however, this was abandoned the following year. In 1880, the first rail line connecting the two countries was completed through Nogales Wash/Potrero Creek canyons. This sparked a land rush of speculators who were trying to establish themselves at the new port-of-entry.

Jacob Isaacson, an itinerant merchant, established a store and post office at the international boundary. For a time, the town which sprung up around the crossing was named Isaacson or referred to as Line City. The Mexican side of the town was called Villa Riva. The name Nogales (Spanish for walnut) eventually became accepted for the town due to the railroad's decision to use the name for the train depot. The railroad brought enough settlers into the area to inhibit the success of the Apache raids, and the communities grew.

Because of its immediate border with Mexico, Nogales, Arizona has developed a strong Mexican-American culture. About 74 percent of the present day population is of Spanish heritage, and most all of the population has some ability with the Spanish language. Ties between the two communities are strong and the twin cities are often referred to as Ambros (both) Nogales.

2. Historic Properties

To date, no significant cultural resources have been identified in the project "Area of Potential Effect" (APE), however, a description of known cultural resources in the vicinity is provided in the attached Environmental Assessment.

3. Population

Population growth in Santa Cruz County and in the City of Nogales has been significant over the past 37 years, increasing 312% and 530%, respectively. Even more significant, however, is the population growth in these two areas over the last 12 years. Nogales has grown from a 1975 population of 10,500 to a 1987 population of 19,615. Santa Cruz County has grown from a 1975 population of 17,300 to a 1987 population of 29,200. The majority of population increase in Santa Cruz County is clearly attributable to Nogales, its largest city. These trends are expected to continue into the future based upon the population projections for Santa Cruz County (Table 8).

Populations in Nogales and Santa Cruz County are projected by the Arizona Department of Economic Security to increase to 59,135 and 75,600 respectively by the year 2035. This is equivalent to an annual rate of growth of

TABLE 8. Population Characteristics

POPULATION PROJECTIONS OF SANTA CRUZ COUNTY AND CITY OF NOGALES

	COUNTY	CITY
1980	20,459	15,603
1985	29,200	19,615
1990	34,100	20,076
1995	39,400	22,776
2000	43,300	26,150
2035	70,100	59,135

Arizona Department of Economic Security, Pop. Stat. Unit

SANTA CRUZ COUNTY POPULATION HISTORY

1910	6,766	1950	9,344
1920	112,689	1960	11,809
1930	29,664	1970	13,706
1940	27,482	1980	20,459

U.S. Department of Commerce, Bureau of the Census

INTERCENSAL POPULATION OF SANTA CRUZ COUNTY 1970-80

1971	14,800	1975	17,800
1972	15,700	1976	18,200
1973	16,500	1977	19,600
1974	17,400	1978	20,000
1975	17,800	1979	20,459

Arizona Department of Economic Security, Pop. Stat. Unit

SANTA CRUZ COUNTY POPULATION BY AGE - July 1, 1980

Under 18 yrs.	3,000	45-64 yrs.	3,400
5-14 yrs.	2,818	65-74 yrs.	2,000
15-19 yrs.	2,182	75-84 yrs.	1,500
20-29 yrs.	2,417	85 & over	2,700

Economic Planning Division, Valley National Bank, based on estimates by Arizona Department of Economic Security, Population Statistics Unit

SANTA CRUZ COUNTY POPULATION BY ETHNIC ORIGIN - July 1, 1980

White	17,800
Indian	1,000
Black	1,000
Hispanic	1,000
Other	1,000

Arizona Department of Economic Security, Population Statistics Unit

GENERAL CHARACTERISTICS OF SANTA CRUZ COUNTY 1980 - APRIL 1980

Number of households	7,000
Percent change, 1970-80	10%
Persons per household	2.0
Median Age	25.0

U.S. Department of Commerce, Bureau of the Census

Table 9. Housing Characteristics

	Santa Cruz County	Nogales Estimate
Housing units.....	6,402.....	4,565
Year-round Housing units....	6,354.....	4,531
Occupied Housing Units		
Owner.....	3,868.....	2,605
Renter.....	2,131.....	1,730
Total.....	5,999.....	4,335

U.S. Department of Commerce, Bureau of the Census

Santa Cruz County Housing Units - Value and Rents - 1980 Census

Value/Owner Occupied: Less than \$20,000.....	259
\$50,000 or more.....	1,121
Median Value.....	\$41,700
Contract Rent/Renter Occupied: Less than \$100.....	531
\$200 or more.....	460
Median Monthly Rent....	\$137

U.S. Department of Commerce, Bureau of the Census

New Housing Units Authorized in Santa Cruz County

1974.....	203	1980.....	127
1975.....	216	1981.....	129
1976.....	167	1982.....	95
1977.....	122	1983.....	111
1978.....	177	1984.....	104
1979.....	241	1985.....	278

Bureau of Business and Economic Research - Arizona State University

approximately 5% for each area. The current population of the Nogales, Sonora community is estimated at 200,000. No projections of the future growth rate available.

4. Land Development

Santa Cruz County is currently in the process of developing a formal existing and proposed land use plan, but at the time of this report, the plan is not complete. The Corps and Santa Cruz County have been working closely however, to ensure that the selected plan(s) will complement the present and expected future land uses.

For the purposes of establishing future hydrologic conditions within the study area, it was important to identify the present area of urban development and predict the future extent of the same. These conditions will affect the ability of the land area to infiltrate precipitation, and as a result, will affect the quantities of flood discharge. The future extent was predicted using preliminary land use plans provided by Santa Cruz County and by identifying lands that have physical characteristics suitable for development. Future development in the Mexico portion of the study area was estimated by evaluating topography and photography for developable lands.

5. Housing

Housing characteristics as determined in the 1980 census are provided in Table 9 (source: U.S. Department of Commerce, Bureau of the Census). This table pertains to Santa Cruz County, however, since 71.3 percent of the county housing units are in Nogales, the data is representative of the study area.

There is little developable land remaining in the City of Nogales. The city is currently involved in implementing a housing rehabilitation program designed to facilitate the rehabilitation of existing single family, owner occupied residential dwellings.

6. Business, Industrial Activities, and Employment

The three main industries in Santa Cruz County are tourism, international trade, and ranching. In the Nogales vicinity, tourism and international trade are predominant. Nogales is the largest port of entry for winter vegetables in the United States. There are over 80 produce firms in Nogales, for which 700 truck loads of produce cross the border each day. Tourists and commercial traffic account for 20,000 crossings per day. Sixty percent of Nogales' sales tax revenues comes from Mexican shoppers who make 45,000 crossings per day.

Of growing importance to the Nogales Community is the in bond or "twin plant" program. In this program, manufacturers establish facilities on both sides of the International Boundary. Products are typically made and/or assembled in Mexico and then returned to the United States for marketing. This allows U.S. firms to take advantage of both significantly lower wages and an abundance of excess labor resources. From its inception in the 1960s, the initial 12 participating companies that set-up dual operations have grown to an estimated 650 companies along the International Boundary as of the end of 1980. Projections indicate that this program will continue to expand and that the majority of future increases in employment opportunities in both Nogales,

Arizona and Santa Cruz County will be either directly or indirectly attributable to the "twin plant" program.

Some signs of the benefits of increased employment are reflected in the increase in retail sales currently being experienced in Santa Cruz County. Retail sales increased from approximately \$93,000,000 in 1974 to \$143,500,000 in 1984. This represents an increase of over 54% in one decade. Associated with this increase is a general increase in the per capita income in Santa Cruz County, rising from \$5,401 in 1977 to \$7,769 in 1983. Of the 8000 employed in Santa Cruz County, 5500 are employed in manufacturing, the wholesale and retail trades, and in services. Approximately 1,600 persons (16.1% of the employable population) are unemployed.

7. Education

Santa Cruz County had an average daily school attendance of 5,707 in the 1984-1985 school season. Approximately 4000 students attended elementary school, the remainder were in high school. Nogales community has one school district. Neither Nogales nor Santa Cruz County have a college.

8. Aesthetic Values Of Existing Environment

Aesthetic values are discussed in the attached Environmental Assessment.

9. Noise

Dominant noise sources adjacent to the Nogales Wash Study area include: automobiles, trucks, motorcycles, emergency vehicles, and railroad. Industrial noise consists of truck loaders at the many produce firms, located adjacent to the Wash. Some heavy construction noise comes from bulldozers, cranes, jack hammers, etc. Within residential areas, light construction noise is produced by saws, hammers, etc. There have been no ambient noise level studies conducted within the study area (Smith, July 1984).

F. RECREATION

Existing formal recreation facilities in the Nogales, Arizona community are illustrated in Table 13 of Chapter III (Problem Identification and Opportunity). Additional facilities including a museum, library, and three recreation centers are open to the general public. Santa Cruz County provides other points of interest and recreation facilities at Tumacacori Mission National Monument, Coronado National Forest, Pena Blanca Lake, Tubac, and Patagonia Lake. Recreation facilities in Nogales, Sonora were not inventoried for this study. Corps recreation staff have estimated that there is a current unmet demand of over 882,000 user days per annum for all types of recreation facilities in the Nogales, Arizona vicinity.

G. TRANSPORTATION

Adjacent to Nogales Wash are two major thoroughfares. The Southern Pacific Railroad, for most of the upstream area through the City of Nogales,

parallels the west bank. A crossover occurs before the city limits and from there on, the tracks parallel the east bank of the wash. State Highway 89 parallels the wash along the west bank through the city limits, and outside the city limits the Wash parallels the Old Tucson Highway rather than the newer I-19 up to the waste water treatment facilities. There are 14 bridge crossings along the Nogales Wash study area. Seven of those are within the city limits and 7 are in the county. One of the city bridges is a brand new structure. There are no dip crossings along Nogales Wash, either in the city or in the county. Nogales International Airport, located approximately 7 miles northeast of Nogales, has a 6,000-foot, paved, lighted runway and is located outside of the city.

H. INSTITUTIONS

The study area contains the City of Nogales, Arizona, which is also the county seat for Santa Cruz County. As such, the institutions associated with city and county governments are located within the study area. The Nogales, Arizona community is also an important international port, and as such, contains several Federal Institutions associated with international relations. These Federal institutions include the Customs Service, Border Patrol, Immigration and Naturalization Service, and the Animal and Plant Health Inspection Service. Other Federal institutions located in the study area are the Forest Service and General Services Administration. The study area also contains the City of Nogales, Sonora, Mexico which is located directly across the International Boundary from Nogales, Arizona. This Sonoran community is heavily urbanized and has a combined permanent and transient population of approximately 200,000. Many of these people have work permits that allow them to cross the border daily. This combined with the fact that the quality and quantity of public services and community facilities in Nogales, Sonora are well below the standard found in the United States, places a significant burden on the Nogales, Arizona community. Water quality in the tributaries emanating from Mexico is typically poor. Also, recent channel improvements in the Sonoran community, and lack of maintenance of existing flood control features has led to an increased flood problem in the Nogales, Arizona community.

CHAPTER III

PROBLEM IDENTIFICATION AND OPPORTUNITIES

A. THE INTERNATIONAL BOUNDARY

Before addressing the main problems which will be identified in this report (water resources), a brief description of the problems and constraints created by the International Boundary should be made.

During the Reconnaissance phase, the study management team met with the United States Commissioner of the International Boundary and Water Commission (IBWC). As a result of this meeting and following conversation, it was decided that potential solutions to the flooding problem would not be considered in Mexico. The primary reason was that the Mexican Government could not financially participate in construction of potential solutions. As a result, only solutions that could be constructed entirely in the United States would be further studied and considered.

The International Boundary also limited access to that portion of the study area in Mexico (48% of the study area or 45 square miles). Construction drawings of the IBWC floodway provided engineering data for the Mexico portion of the study area. Channel characteristics for the mainstream above the IBWC system (Reach 1) were analyzed primarily from photos and some topographic mapping, and several field trips.

B. FLOODING

1. General Overview

The Nogales Wash/Potrero Creek drainage area is relatively small (94.4 square miles) and highly reactive to flood conditions. To a large part, developed Nogales communities are located in the narrow (less than 1/2 mile wide) valley floors, adjacent to the normally dry, but potentially flood prone washes. Surrounding terrain is steep and rocky. Recent development within both Nogales, Arizona and Nogales, Sonora has decreased the potential of infiltration. This trend is likely to continue making future flood conditions even worse.

Well over 2000 residents live in the Nogales Wash floodplain within the United States portion of the study area. Approximately 500 residential units, 92 commercial businesses, 70 industrial buildings, and 14 public/governmental facilities are located within the flood boundaries.

Significant social disruption is prevalent as a result of flooding or even the threat of flooding. In the downtown Nogales, Arizona community, flooding brings to a halt the routine activities associated with major international ports. Vehicular and pedestrian traffic, government operations, produce transfer, retail shopping and tourism are all squelched, resulting in significant loss of time and money to the local and national economy.

In the residential community of Chula Vista, flood flows from Nogales Wash and Potrero Creek damage homes and property and threaten human life. Some residences in the neighborhood have reportedly been flooded almost every year since the neighborhood was constructed in 1971. In attempts to protect their own property, some residents have constructed flood walls which create worse conditions for neighboring properties. Property values have decreased significantly as a result of the flood threat although residents have made tremendous efforts to repair flood damage.

Frequent nuisance flooding results in significant cleanup and repair costs for the entire community. Larger flood events cripple the community for weeks and even months, causing significant flood damages and threat to human life. Fear of flooding is significant to the community year-round. Summer thunderstorms send weary residents home to protect their family and property. Even greater fear exists at night due to the possibility of flash flooding while residents sleep.

2. Historical Flood Damages

The twin cities of Nogales, Arizona and Nogales, Sonora have a long flood history. The International Boundary and Water Commission (IBWC) reported major floods in 1905, 1909, 1914, 1915, 1926, 1930, and 1931 within Senate Document number 44. The flooding in 1930 claimed five lives and caused property damage of over \$200,000 (\$5.6 million in 1986 dollars). These flood damages led to the construction of the existing flood control channels in the 1930s and 1940s. Initially, this system was effective, however, over the years, increased development and land use changes on both sides of the International Boundary have resulted in increased flood damages and frequency.

More recently, the flood in October 1977 resulted in flood damages of \$700,000 (\$1,100,000 in October 1986), inundated over 40 homes, caused significant damage to the International Waste Water Treatment Plant, and eroded portions of the Southern Pacific railroad embankment, and several acres of land adjacent to Nogales Wash, and caused the drowning of three individuals. Of this \$1,100,000 in total flood damages approximately \$685,000 was incurred in residential and railroad (physical) damages, and emergency costs. Above the Chula Vista subdivision (C.P. 10) the peak discharge was 4200 cfs, which corresponds to approximately an 8-year event. This leads to expected damages of about \$900,000 compared to \$685,000 in damages that were actually reported.

Flooding in 1978-1980 resulted in Nogales being included in a Presidential disaster area two more times although flood damages were considerably less than in 1977. In the fall of 1983, the remnants of hurricane Octave caused a flood which produced over \$500,000 in damages (\$520,000 in October 1986), significant erosion, and once again, the inclusion within a Presidential disaster area.

3. Projected Damages

Table 10 illustrates the property inventory and values contained within the 500-year floodplain of the Nogales Wash/Potrero Creek mainstem. Table 11 illustrates the estimated damages that would occur by flood event.

Table 10. Property Value By Reach Within 500 Year
Floodplain, (October 1986 \$X1000)

STUDY AREA INVENTORY BY CATEGORY	Units	Structure Value	Content Value	TOTAL VALUE
Single Family Residential	293	18,342	9,162	27,504
Multi Family Residential	27	5,198	2,593	7,791
Commercial	92	28,759	28,180	56,939
Industrial	70	18,421	10,712	29,133
Mobile Home	114	2,359	1,183	3,542
Public	14	6,182	2,058	8,240
GRAND TOTAL (ALL REACHES)	610	79,262	53,888	133,150
REACH 2A	Units	Structure Value	Content Value	TOTAL VALUE
Single Family Residential	56	3,194	1,597	4,791
Multi Family Residential	6	1,094	547	1,641
Mobile Home	1	16	8	24
Commercial	48	16,852	16,852	33,704
Industrial	31	5,990	5,356	11,346
Public	4	1,138	397	1,535
REACH 2 TOTAL	146	28,284	24,757	53,041
REACH 3	Units	Structure Value	Content Value	TOTAL VALUE
Single Family Residential	80	3,121	1,561	4,682
Multi Family Residential	7	2,063	1,031	3,094
Mobile Home	20	156	78	234
Commercial	6	3,416	3,416	6,832
Industrial	20	2,495	3,010	5,505
Public	5	3,947	1,302	5,249
REACH 3 TOTAL	138	15,197	10,398	25,595
REACH 4 (SUBREACHES 1-4)	Units	Structure Value	Content Value	TOTAL VALUE
Single Family Residential	24	6,317	3,152	9,469
Multi Family Residential	14	2,042	1,015	3,057
Commercial	35	8,432	7,853	16,285
Industrial	19	9,936	2,345	12,281
Mobile Home	5	1,150	580	1,730
Public	5	1,097	359	1,456
REACHES 4-1 THRU 4-4 TOTAL	102	28,974	15,303	44,277
CHULA VISTA	Units	Structure Value	Content Value	TOTAL VALUE
Single Family Residential	122	4,612	2,306	6,918
Mobile Home	86	1,009	504	1,513
CHULA VISTA (REACH 4-5) TOTAL	208	5,621	2,811	8,432
FROM CHULA VISTA TO END OF STUDY AREA	Units	Structure Value	Content Value	TOTAL VALUE
Single Family Residential	11	1,099	547	1,646
Commercial	3	59	59	118
Mobile Home	2	29	13	42
REACHES 4-6 AND 4-7	16	1,186	619	1,805

TABLE 11. Without Project Damages By Reach Per Event
(October 1986 \$x1000 Price Levels @ 8 7/8%)

* TOTAL STUDY AREA BY CATEGORY	20 YR	50 YR	100 YR	200 YR	500 YR	Average Annual
Residential Structures	1,882	3,382	4,802	6,773	9,133	
Contents	1,316	2,249	3,282	4,416	6,130	
Mobile Home Structures	58	476	683	771	815	
Contents	1	162	293	357	397	
Commercial Structures	1,246	2,993	4,631	6,315	8,785	
Contents	1,620	3,941	6,046	7,860	10,503	
Warehouse Structures	449	659	1,021	1,433	2,149	
Contents	468	669	905	1,112	1,460	
Public Structures	163	429	570	715	1,022	
Contents	61	187	246	319	461	
Emergency	196	405	682	794	954	
RR/Utility	329	802	1,269	1,839	2,799	
GRAND TOTAL (ALL REACHES)	7,787	16,354	24,522	32,704	44,607	1,891

* REACH 2A	20 YR	50 YR	100 YR	200 YR	500 YR	Average Annual
Residential Structures	274	723	1,178	1,791	2,543	
Contents	222	499	799	1,205	1,710	
Commercial Structures	1,060	2,604	3,510	4,520	5,839	
Contents	1,408	3,439	4,580	5,642	6,988	
Warehouse Structures	245	357	427	521	653	
Contents	410	587	666	773	941	
Public Structures	146	388	508	671	871	
Contents	52	171	216	278	353	
Emergency	4	17	39	68	101	
RR/Utility	73	236	412	654	788	
REACH 2 TOTAL	3,899	9,022	12,336	16,131	20,787	999

* REACH 3	20 YR	50 YR	100 YR	200 YR	500 YR	Average Annual
Residential Structures	0	5	345	721	1,383	
Contents	0	3	221	480	924	
Commercial Structures	0	9	442	706	1,157	
Contents	0	13	614	920	1,442	
Warehouse Structures	0	1	46	77	133	
Contents	0	2	78	96	127	
REACH 3 TOTAL	0	32	1,745	3,000	3,165	48

* REACH 4 (SUBREACHES 1-4)	20 YR	50 YR	100 YR	200 YR	500 YR	Average Annual
Residential Structures	533	1,146	1,532	2,000	2,742	
Contents	316	751	1,061	1,363	1,846	
Commercial Structures	186	379	674	1,072	1,774	
Contents	212	489	847	1,287	2,054	
Warehouse Structures	204	301	549	835	1,364	
Contents	58	80	161	243	392	
Public Structures	17	41	62	44	151	
Contents	8	16	30	41	107	
Emergency	59	120	153	211	319	
RR/Utility	178	349	530	702	1,252	
REACHES 4-1 THRU 4-4 TOTAL	1,774	3,671	5,598	7,797	12,001	357

* CHULA VISTA	20 YR	50 YR	100 YR	200 YR	500 YR	Average Annual
Residential Structures	974	1,271	1,455	1,900	2,037	
Contents	706	858	1,005	1,143	1,384	
Mobile Home Structures	58	476	688	771	815	
Contents	1	162	293	357	397	
Emergency	77	152	362	374	374	
CHULA VISTA (REACH 4-5) TOTAL	1,816	2,929	3,804	4,554	5,007	439

* CHULA VISTA TO END OF STUDY AREA	20 YR	50 YR	100 YR	200 YR	500 YR	Average Annual
Residential Structures	100	236	293	352	428	
Contents	72	139	196	226	267	
Commercial Structures	0	1	5	9	14	
Contents	0	1	5	12	19	
Emergency	56	117	128	140	159	
RR/Utility	73	217	327	483	759	
REACHES 4-6 AND 4-7	301	711	953	1,222	1,646	48

4. Discharge Frequency Characteristics

As was discussed in Chapter 2, Section C.2.a., there may be a difference between present condition and future condition flood frequency at a specific concentration point due to ongoing and future urban development within the drainage basin. A summary of the present and future condition without project discharge-frequency values developed by Corps engineering staff and used in this feasibility phase analysis is provided in Tables 12A and 12B.

5. Flood Characteristics

The following discussion briefly describes the flood characteristics reach by reach.

* Reach 1 (Upstream Section)

The upstream section in Mexico is entrenched. Flooding in the adjacent urban community occurs as channel capacity is exceeded. Flood flows are typically carried by paved streets.

* Reach 2 (Covered concrete channel section; in U.S. & Mexico)

Flooding in this reach occurs, because of three factors (see Figure 5 for locations of inlets and contributing drainage areas). First, that portion of flood waters which exceed the channel capacity upstream in reach 1, are carried down streets and miss the main inlet (CP1). This occurs with 5-year or less frequent flood events. Second, the main inlet itself starts overtopping with flood flows of approximately 4200 cfs (14-year present condition, 10-year future condition) even though the channel itself has a capacity of 4900 cfs. Third, interior drainage downstream of the main inlet has minimal chance of getting into the covered channel, since side drains are few and typically plugged. This fact results in some street flooding downstream of the main inlet at a low frequency (approximately 1-year).

Flooding caused by any of the three factors, is carried in the streets and produces damage to primarily commercial businesses. Many of these businesses have basements that would incur significant damages if flooded. Floodflow would move in a northerly direction through the downtown communities and would co-mingle with the flows in the covered channel downstream of the outlet area.

* Reach 3 (Open concrete channel section)

The majority of the channel in Reach 3 is entrenched, however, some portions are contained with a low parapet wall. Flooding occurs in this reach as a result of street flows originating in reaches 1 and 2, as interior tributary drainage from Ephraim Canyon Wash and other sources, or as breakouts from either of two low bridge crossings.

* Reach 4 (Unimproved section) and

* Reach 5 (Downstream section)

Table 12A. Summary of Discharge-Frequency Results
(Present Conditions Without Project)

Concentration Point	Location	Drainage Area (mi ²)	10-year Flood (cfs)	25-year Flood (cfs)	50-year Flood (cfs)	100-year Flood (cfs)	500-year Flood (cfs)	SPF (cfs)
Nogales Wash								
1	Inlet to Nogales Covered Channel	24.4	3400	6100	8900	12000	24000	31000
2	South Inlet to Arroyo Boulevard Channel	0.56	310	500	660	940	1800	2300
3	West Inlet to Arroyo Boulevard Channel	1.7	690	1100	1400	1600	2700	3500
4	International Boundary	28.0	3900	5900	9200	13000	26000	34000
5	Below Nogales & Arroyo Channels	28.9	3700	5700	9100	13000	26000	34000
6	Below Ephraim Canyon Wash	41.1	4700	7800	11000	16000	33000	45000
7	AZ-189 Bridge over Nogales Wash	42.9	4600	8000	11000	16000	34000	45000
8	Above Escalada Road	58.3	4900	8900	13000	19000	40000	53000
9	On Potrero Creek between AZ-189 & I-19	14.1	2100	3600	5100	7100	14000	18000
10	Above Chula Vista Subdivision	61.4	4800	8800	13000	19000	40000	54000
Potrero Creek								
11	Below Nogales Wash & Potrero Creek Confluence	76.5	5600	11000	15000	22000	47000	65000
12	Below Alamo Canyon Wash Confluence	82.7	5700	11000	16000	23000	50000	69000
13	Below Pesquitera Canyon Wash Confluence	90.5	5800	12000	17000	24000	54000	75000
14	Above Santa Cruz River Confluence	93.6	5600	11000	16000	24000	54000	74000

Table 12a. Summary of Discharge-Frequency Results
(Future Conditions Without Project)

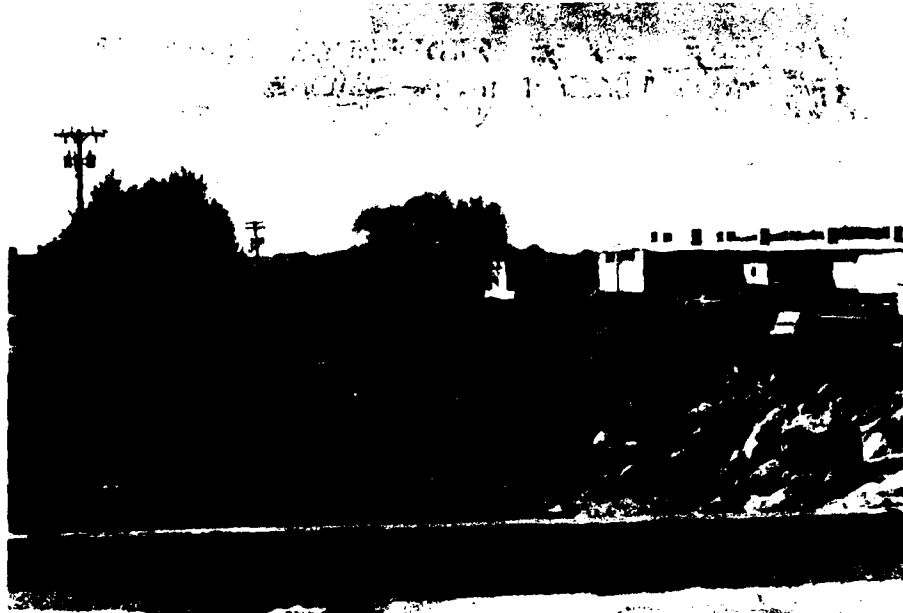
Concentration Point	Location	Drainage Area (mi ²)	10-year Flood (cfs)	25-year Flood (cfs)	50-year Flood (cfs)	100-year Flood (cfs)	500-year Flood (cfs)	SPF (cfs)
Nogales Wash								
1	Inlet to Nogales Covered Channel	24.4	4100	7100	9900	14000	26000	33000
2	South Inlet to Arroyo Boulevard Channel	0.56	340	540	700	980	1900	2400
3	West Inlet to Arroyo Boulevard Channel	1.7	820	1200	1500	1700	2900	3700
4	International Boundary	28.0	4900	6400	10000	14000	28000	37000
5	Below Nogales & Arroyo Channels	28.9	4700	6100	10000	14000	28000	37000
6	Below Ephraim Canyon Wash	41.1	5900	8400	12000	17000	35000	48000
7	AZ-189 Bridge over Nogales Wash	42.9	5700	8600	12000	18000	36000	48000
8	Above Escalada Road	58.3	6000	9700	14000	21000	42000	56000
9	On Potrero Creek between AZ-189 & I-19	14.1	2300	3800	5300	7300	15000	19000
10	Above Chula Vista Subdivision	61.4	5900	9700	14000	21000	43000	57000
Potrero Creek								
11	Below Nogales Wash & Potrero Creek	76.5	6700	12000	16000	23000	51000	69000
Below Alamo Canyon Wash Confluence								
13	Below Pesquera Canyon Wash Confluence	90.5	7100	13000	18000	26000	57000	78000
14	Above Santa Cruz River Confluence	93.6	6900	13000	17000	26000	57000	77000

Table 12. Summary of Discharge-Frequency Results
(Present Conditions With Project)

Concentration Point	Location	Drainage Area (mi ²)	10-year Flood (cfs)	25-year Flood (cfs)	50-year Flood (cfs)	100-year Flood (cfs)	500-year Flood (cfs)	SPP (cfs)
Nogales Wash								
1	Inlet to Nogales Covered Channel	24.4	3400	6100	8900	12000	24000	31000
2	South Inlet to Arroyo Boulevard Channel	0.56	310	500	660	940	1800	2300
3	West Inlet to Arroyo Boulevard Channel	1.7	690	1100	1140	1600	2700	3500
4	International Boundary	28.0	3900	5900	9200	13000	26000	34000
5	Below Nogales & Arroyo Channels	28.9	4000	6100	9200	13000	26000	34000
6	Below Ephraim Canyon Wash	41.1	5000	8300	12000	16000	33000	45000
7	AZ-189 Bridge over Nogales Wash	42.9	4900	8400	12000	16000	34000	45000
8	Above Escalada Road	58.3	5200	9400	13000	19000	40000	53000
9	On Potrero Creek between AZ-189 & I-19	14.1	2100	3600	5100	7100	14000	18000
10	Above Chula Vista Subdivision	61.4	5100	9200	13000	19000	40000	54000
Potrero Creek								
11	Below Nogales Wash & Potrero Creek Confluence	76.5	5900	11000	16000	23000	47000	65000
12	Below Alamo Canyon Wash Confluence	82.7	5900	12000	16000	24000	50000	69000
13	Below Pesquiera Canyon Wash Confluence	90.5	6100	12000	17000	25000	54000	75000
14	Above Santa Cruz River Confluence	93.6	5900	12000	17000	24000	54000	74000

Table 12b. Summary of Discharge-Frequency Results
(Future Conditions With Project)

Concentration Point	Location	Drainage Area (mi ²)	10-year Flood (cfs)	25-year Flood (cfs)	50-year Flood (cfs)	100-year Flood (cfs)	500-year Flood (cfs)	SPP (cfs)
Nogales Wash								
1	Inlet to Nogales Covered Channel	24.4	4100	7100	9900	14000	26000	33000
2	South Inlet to Arroyo Boulevard Channel	0.56	340	540	700	980	1900	2400
3	West Inlet to Arroyo Boulevard Channel	1.7	820	1200	1500	1700	2900	3700
4	International Boundary	28.0	4900	6400	10000	14000	28000	37000
5	Below Nogales & Arroyo Channels	28.9	4900	6500	10000	14000	28000	37000
6	Below Ephraim Canyon Wash	41.1	6100	8800	13000	17000	35000	48000
7	AZ-189 Bridge over Nogales Wash	42.9	6000	9000	13000	18000	36000	48000
8	Above Escalada Road	58.3	6200	10000	15000	21000	42000	56000
9	On Potrero Creek between AZ-189 & I-19	14.1	2300	3800	5300	7300	15000	19000
10	Above Chula Vista Subdivision	61.4	6100	10000	14000	21000	43000	57000
Potrero Creek								
11	Below Nogales Wash & Potrero Creek Confluence	76.5	7000	12000	17000	25000	51000	69000
12	Below Alamo Canyon Wash Confluence	82.7	7100	13000	17000	26000	54000	73000
13	Below Pesquera Canyon Wash Confluence	90.5	7300	13000	19000	27000	57000	78000
14	Above Santa Cruz River Confluence	93.6	7100	13000	18000	26000	57000	77000



Typical view of Reach 4 near Valle Verde. Most warehouse here have platforms 4-5 feet above grade.



"Bank erosion". As a result of the October 1983 storm and flood, several buildings and many acres of land were lost by bank erosion. This photo was taken just across the wash from Firestone Gardens.



"Typical street flooding in downtown Nogales, Arizona."
This picture taken in 1984 illustrates an almost yearly occurrence.



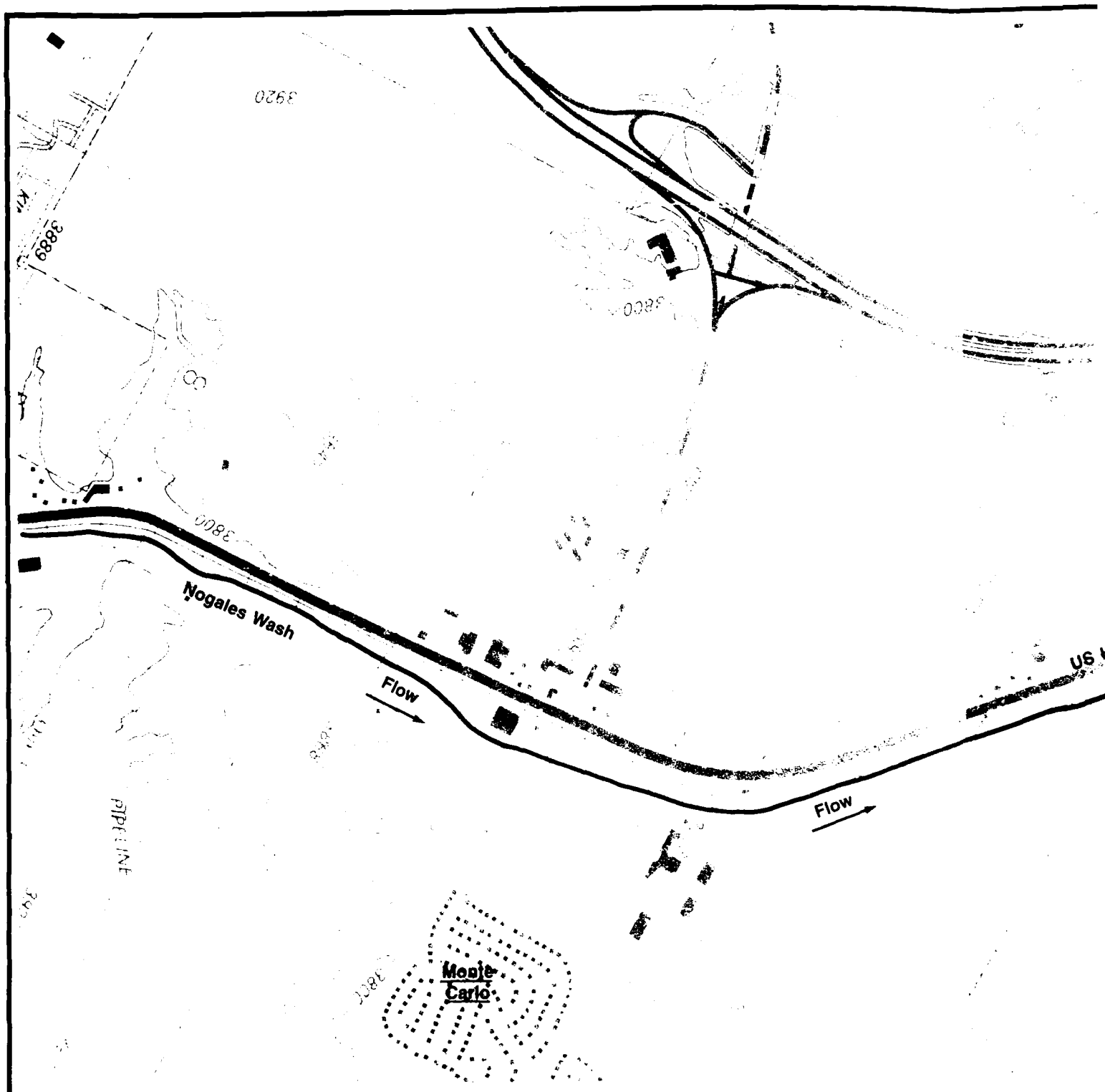
"Typical street flooding in downtown Nogales, Arizona."
This picture taken in 1984 illustrates an almost yearly occurrence.



The open concrete channel is filled with floodflow from a typical summer thunderstorm.

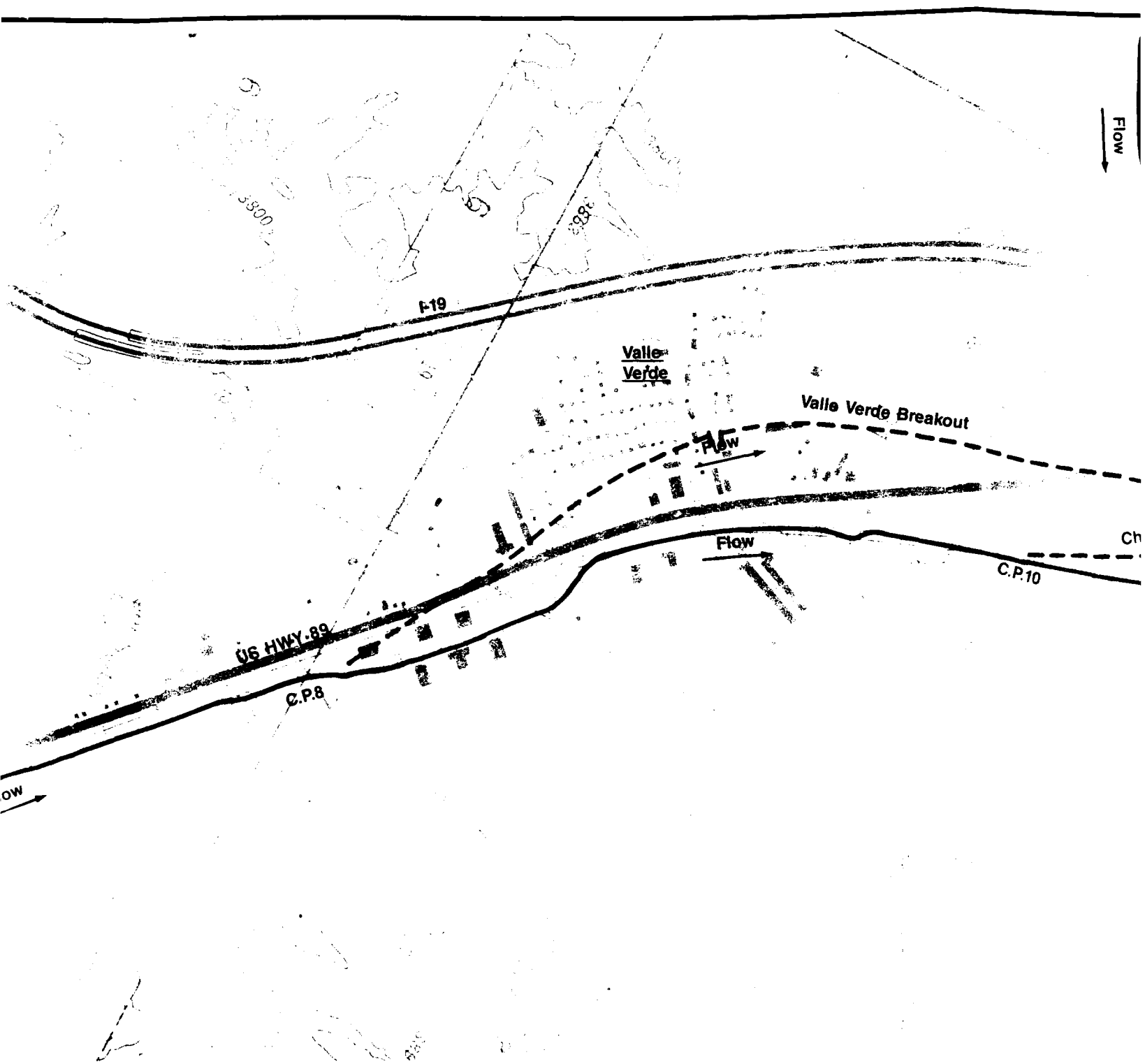


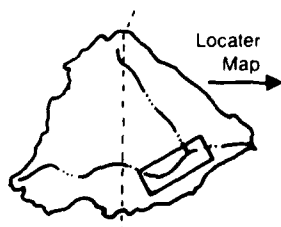
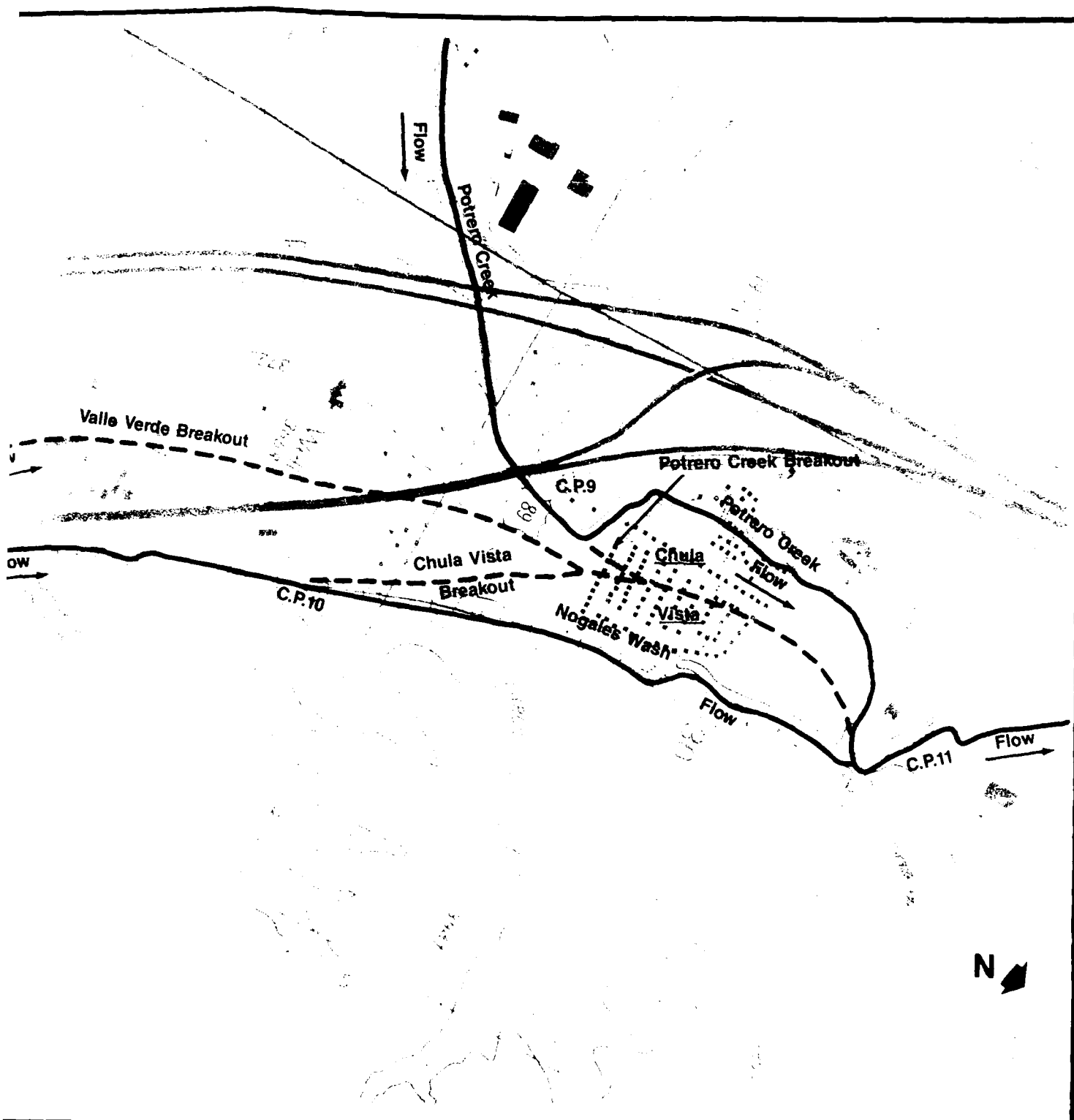
The open concrete channel is filled with floodflow from a typical summer thunderstorm.



LEGEND

- Existing Incised Mainstem Channel
- - - Existing Breakout Locations
- CP# Concentration Point





0' 500' 1000' 2000'

Scale 1" = 1000 ft.

Figure 7
NOGALES WASH
Breakout Locations

There are two major locations where breakout occurs and follows an out-of-channel thalweg (Figure 7). The first out-of channel thalweg begins upstream of, and flows through the Valle Verde community, co-mingles with Potrero Creek about 7000 feet downstream, and then flows through the Pete Kitchen community to the confluence of Nogales Wash near (CP11). This breakout occurs as sheet flow in the Valle Verde community when channel flow of Nogales Wash exceeds 2500 cfs (3-year future condition).

The second out-of-channel thalweg begins upstream of Chula Vista near the Villa Hermosa apartment complex. This breakout follows a north westerly direction and co-mingles with the Valle Verde-Potrero Creek alignment to the confluence with Nogales Wash at (CP11). This breakout occurs when channel capacity of Nogales Wash exceeds 2000 cfs (2-year future condition).

Flooding in the Chula Vista-Pete Kitchen subdivision may come from any or all of three different sources. With a basin wide storm, flooding in the subdivision would typically start with overflow from Potrero Creek. With increased flood volume, Nogales Wash would then overtop its bank just upstream of Chula Vista and would combine with the Potrero Creek overbank flow. With only a small addition of flood volume, the Valle Verde breakout would combine with the other two flows.

The Potrero Creek floodwaters, the Nogales Wash breakout, and the Valle Verde breakout, combine just south of Chula Vista and flow towards the existing Potrero Creek alignment. As flood volume increases, this flow spreads out and follows a more direct route through the Chula Vista-Pete Kitchen subdivision. This may occur with approximately a two year flood frequency from Potrero Creek, approximately a three year frequency from Nogales Wash. The Nogales Wash floodwaters, which break out just upstream of Chula Vista, flow towards the southwest corner of Chula Vista, however, as flood volume increases, this flow fans out and penetrates the subdivision boundary further to the east. At most other locations within reaches 4 and 5, the Nogales Wash-Potrero Creek mainstream is entrenched so breakout does not take other courses.

C. BANK EROSION

Bank erosion is a serious problem in the unimproved section adjacent to and downstream of Chula Vista (Reach 4A). The erosion problem in this 11,100 foot long reach was analyzed by comparing stream bank locations identified from 4 different historical aerial photo flights (1959, 1963, 1975, and 1983). The analysis, which covered a total 24 year period (1959 to 1983) found that a total of approximately 44.6 acres of land had been lost by stream bank erosion. The average rate of this erosion was 1.9 acres per year. Between 1983 and 1986, significant erosion was reported, but the quantities are undocumented. Ground surveys of the erosion areas show that most erosion takes place where stream banks are high (10 to 15 feet).

Most of the land adjacent to the mainstem in Reach 4A is rural in character. Several residential subdivisions and an industrial park border the wash, but most of the land is either underdeveloped or fallow farmland. In recent years, several houses have been lost due to bank erosion. In 1983 a single event resulted in a lateral loss of 80 feet of bank and undermined a

house near Firestone Gardens. Most of the land which is subject to erosion is within the floodway and under these conditions, will not be developed.

Prior to 1985, Santa Cruz County made several attempts to curb the erosion of lands located in the northeast corner of Chula Vista. Frequent floods negated these attempts. In 1985, the County constructed a soil cement revetment which thus far is effective. Two lines of Kellner jacks near the Firestone Garden Community also appear to have stopped erosion there.

D. WATER SUPPLY

The main water supply problem in the Nogales community is the susceptibility of the drainage basins to periods of drought (one year or longer). This is primarily due to the small size and limited storage of the aquifer. During extended dry periods when flow in the Nogales Wash-Potrero Creek mainstream is zero or nearly zero, the City of Nogales has considerable difficulty in satisfying its demands for water.

E. WATER QUALITY

Traditionally there have been rather serious water quality problems existing at Nogales, Arizona, due to a high fecal coliform level in Nogales Wash. The problems are primarily associated with surface water, not groundwater. With the population of Nogales, Sonora, exceeding 200,000, the problem of waste treatment has posed a threat to the downstream flow of Nogales Wash across the International Border and into Nogales, Arizona. The International Boundary and Water Commission (IBWC) has been aware of this problem for a number of years. Communiques between the IBWC and various state and local officials go back into the late 1960's and early 1970's.

Increasing industrialization on both sides of the border could potentially effect water quality. Chemical spills could easily contaminate the small underlying aquifer. The smell associated with raw sewage in Nogales Wash is also an identifiable problem. The intensity of the smell increases in relationship to the quantity of sewage in the stream flow.

F. RECREATION

Recreation facilities in the Nogales Wash project are heavily used, and with projected population growth, the City of Nogales is in urgent need of additional public recreation facilities. Table 14 illustrates the current unmet demand for basic facilities such as multi-use parks with picnicking areas, baseball/softball fields, hiking and biking trails and playgrounds.

This unmet demand is in terms of "recreation days" and is based upon the 1987 population of Nogales, Arizona (22,900). The real demand is even more severe considering that an undocumented portion of the Nogales, Sonora community (+200,000) do make use of the facilities in Nogales, Arizona. Development of recreation facilities within project lands would provide the opportunity to reduce the unmet recreation demand.

Two types of opportunities should be considered. First, the opportunity for enhancing water related recreation and second, the opportunity for any and all types of recreation on potential project property. At present, there is little

Table 13. Existing Recreation Facilities in Nogales, Arizona *

Name	Facilities	Water	RstRms	Change**	Heavy Use	Lite Use	Park Population
Memorial Park (Madison Street)	Pool, baseball field, dug outs, bleachers, children's playground	X	X	X	X		300/day
Anza Park (Kino Blvd.)	Tennis (1 court), handball	X	X			X	50/day
Madison St. Park	Tennis (1 court)	X				X	50/day
City Hall Park (Grand Ave.)	Basketball, playground, Little League Field, Childrens soccer, BBQ Pits, Picnic tables	X	X		X		50/day
Beck St. Park	Basketball, playground	X				X	75/day
Fleicher Park (Bankert St.)	Baseball field (hard/soft) soccer field, grandstands Little League Field, Bicycle trail	X	X		X		500/day
Karim Park (Morley Ave)	No facilities except gazebo (small park)	-X	X		X		350/day
Capin Park (Grand Ave)	No facilities except land- scaping and Gazebo (small park)					X	50/day
Kino Park (Kino Blvd)	No facilities except land- scaping					X	50/day
City Hall / Brand Ave Park	No facilities except land- scaping				X		500/day
Meadow Hills Golf Course (Country Club Road)	9-Hole golf course, pool	X	X	X			(not open yet)
Old Armory Building (Madison St)	Basketball	X	X		X		100/day
Wade Carpenter Jr. High	Pool, children's pool	X	X	X	X		500/day

* City officials qualify these numbers by noting that most park use is on weekends.

** Denotes whether facilities for changing clothes are available.

Table 14. Recreation Supply and Demand w/ Project
(In Recreation Days)

Activity	Current Demand Based on Nogales Ariz. population	Max. Supply in the U.S. Portion of the study area	Current Unmet Demand
Picnicking	211,000	30,000 (31,799)*	181,000 (179,201)*
Playgrounds	238,000	20,000	218,000
Hiking	137,000	25,000 (25,500)*	112,000 (111,500)*
Biking Trails	318,000	45,000 (45,900)*	273,000 (272,100)*
Court Sports	82,000	22,000	60,000
Horseshoes	41,000	3,000	38,000
	1,027,000	145,000 (148,199)*	882,000 (878,801)*

*includes w/project supply (see Recreation section in Technical Report) for origin of Maximum Annual Recreation Days provided by the project.

opportunity to enhance water related recreation (swimming, fishing, and boating) in the study area as Nogales Wash Potrero Creek does not provide the physical characteristics that would be required. These activities are prohibited due to water quality and quantity.

The riparian habitat and wildlife along the wash, however, do provide some opportunity for passive entertainment and trails. Potential recreation features would be restricted to lands required as part of the flood control project.

G. ENVIRONMENTAL

The most serious environmental concern in terms of water resources is the ongoing loss of the riparian habitat, as this habitat is extremely important to wildlife in the desert southwest, providing areas of food, cover and water for both resident and migratory species. This habitat type has been severely reduced in both quality and quantity by flooding and bank erosion, active cutting by land owners, and land use changes, all to the detriment of wildlife species that depend upon it. In recent history, stands of riparian habitat have been removed to increase channel capacity and reduce flooding. It is likely that this trend will continue along with the natural forces to reduce this habitat even more.

H. HISTORIC PROPERTY

The most serious concern in regard to historic property in the study area is the potential loss of articles not yet found or identified. In the past, such articles have been carelessly destroyed or stolen.

Although no artifacts have been identified in the project Area of Potential Effect (APE), a recent (late in the feasibility phase) find of Hohokam pottery shards near a potential project site (between CP11 and CP12) has alerted archaeologists that there may be more sites in the APE. It has been determined that some subsurface testing will be required prior to construction. The Corps intends to accomplish this testing in the Preconstruction Engineering and Design (PE&D) phase. This testing will provide the opportunity to find, identify, inventory, and determine the integrity/significance of cultural and historical properties which otherwise might be lost.

I. HOUSING AND LAND DEVELOPMENT PROBLEMS AND OPPORTUNITIES

The Nogales area's need for housing is acute. One thousand new housing units are needed to accommodate the future projected population, according to the City of Nogales Housing Assistance Plan. Also there is tremendous opportunity for commercial growth with the twin plant program (see Chapter II, section 6), but the availability of developable lands is again a limiting factor. Removal of lands from flood prone areas would provide an opportunity for additional community growth (both residential and commercial). A flood control project may also provide an opportunity to restore the property value of existing homes and businesses that are currently in flood prone areas.

J. PUBLIC CONCERNS

Although public concerns are expressions of personal values and do not necessarily represent the total population, concerns about flooding in the Nogales community are based upon a real and significant problem, and are expressed by the community as fear. At various times, such as the summer thunderstorm season, people living in flood prone areas center their lives around the fear of flooding. Much attention is paid as thunder heads build. Workers often leave for home early to secure their family and property. Work, shopping and vacation activities are all centered around the fear of flooding.

The main reason cited for this fear of flooding is the potential loss of life. Historically, flooding in the study area has claimed eight lives (5 in 1930, and 3 in 1977). Numerous houses along the Nogales Wash-Potrero Creek mainstem are in immediate danger of flooding. Residents are particularly concerned about the short warning time and the fact that peak discharge typically occurs within a few hours after the storm starts. This is particularly of concern since runoff from summer thunderstorms often occur at night when residents are sleeping.

Residents and property owners are also concerned about flood damage as outlined in Section B of this chapter. Related to flood damage is the depressed property value that has occurred in locations that receive frequent flooding. For example, some homes in the Chula Vista community receive flood damage every few years. Homes in that subdivision don't sell well and those that are sold, sell at a deflated value because of their location.

Residents on the United States side of the International Boundary have expressed fear about the potential flood threat coming from Mexico. The fear arises from the conjecture that channel improvements and continued growth on the Mexican side are making flood conditions on the United States side worse. Some residents also fear that a dam in Mexico (Las Chimeneas) may fail during a storm and send a wall of water through the community. The IBWC, however, has examined this facility on several occasions and has found that "there does not appear to be any concern for the structural safety of the dam", in part, because of the detached spillway that is cut through stable bedrock. These findings have been provided to the Arizona Department of Water Resources. The fear concerning flooding from Mexico, however, is probably a manifestation of the fact that the United States government has no direct control over development and flood control features in Mexico. Finally, residents feel that the flood problem is increasing with time. This magnifies the community's concerns even more.

Opportunities to solve the flooding problem may also provide resolution to these social fears expressed by the community. This resolution would probably lead to a more productive society.

IV. PLAN FORMULATION

Plan formulation is a creative and analytical process which involves (1) establishing objectives, (2) delineating specific criteria, (3) identifying management measures, and (4) formulating alternative plans.

Plan formulation is an iterative process, and in reality, takes place many times throughout a study. As input data changes or as new data becomes available, reformulation takes place. This feasibility study was formally broken into two phases, the reconnaissance phase and the feasibility phase. For purposes of illustrating plan formulation of this study in a clear and methodical format, however, the two phases are broken into four iterations, each based upon significant changes and the development of new data. These iterations are described in detail in Section E of this chapter.

This chapter will outline the planning objectives (Section A); identify the formulation and evaluation criteria used (Section B) as well as management measures considered (Section C); will describe the relationship of this study to other ongoing studies (Section D); will illustrate the development of management measures (Section E); and alternatives plans (Section F), will compare the alternative plans (Section G), and will describe the basis for identifying "the recommended plan".

A. PLANNING OBJECTIVES

The objective of water and related land resources project planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable Executive Orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services. Water and related land resources project plans are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective.

The following planning objectives were established by the various publics and the Corps to address the problems and realize the opportunities identified in the Nogales area, and to serve as guidelines for the formulation and evaluation of alternative plans.

OBJECTIVES:

- * Reduce flood and erosion damages to residential, commercial and industrial property, community infrastructure, and transportation corridors along the Nogales Wash-Potrero Creek mainstream, and to protect and promote economic development in the community.

- * Enhance recreation opportunities, where feasible, within project boundaries.

- * Protect and, as appropriate, enhance for existing riparian habitat and wildlife resources within project boundaries.

*Preserve existing historical, cultural, and archaeological resources within the Area of Potential Effect. (APE).

*Improve, where feasible, water quality and water quantity within the study area.

B. FORMULATION AND EVALUATION CRITERIA

Water and related land resources plans are primarily formulated to alleviate problems and take advantage of opportunities that occur at the national, State and local levels in ways that contribute to and maximize the National Economic Development (NED) objective. The additional consideration of environmental quality (EQ), regional economic development (RED), and other social effects (OSE) are also evaluated. The EQ account displays nonmonetary effects on significant natural and cultural resources. The RED account registers changes in the distribution of regional economic activity that results from each alternative plan. The OSE account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

Because of their broad nature, these objectives and accounts have been redefined in terms of criteria relating to the problems and opportunities being investigated. These criteria provide the framework for consistent formulation and evaluation of all measures and alternatives. The following is a list of these criteria.

CRITERIA:

1. Flood and Erosion Control

* Plans should be consistent with Santa Cruz County and City of Nogales general plans.

* The selected plan should not worsen existing flood hazards for downstream developments without measures to compensate for the effects.

* Plans must be technically feasible using currently acceptable engineering methods and techniques.

* Plans must be generally acceptable to the public (all non-Corps entities).

* The selected plan should be complete in and of itself and should not require additional improvements in the future.

2. Recreation

* Recreation plans should complement State and local plans.

* Recreation plans should be compatible with other recreational developments in the study area.

* Recreation facilities should be planned to utilize the potential of the resources within the lands required for flood control and other project purposes.

* Recreation plans should be compatible with and supported by non-Federal interests for sharing project costs and assuming operation and maintenance responsibilities.

* Plans should be compatible with other study objectives,

3. Economic Criteria

* The benefits and costs should be expressed in comparable terms as fully as possible. All evaluations of alternatives should be based on the same price level and the same interest rate, and a project life appropriate to the plans being studied, but in no case greater than 100 years.

* Each alternative considered in detail must be "justified" in the sense that total beneficial effects associated with the objectives are equal to or exceed the total adverse effects associated with the objectives.

* Project benefits should be based on analyses of conditions without and with a project, using methodologies described in "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" and Corps of Engineers regulations.

4. Environmental Criteria

* Plans should be formulated to preserve and enhance the quality of the natural environment. To the extent practical, significant resources including riparian habitat and associated wildlife, land, air, water, open space, scenic and aesthetic values should be preserved and enhanced. Any adverse effects which cannot be avoided, if a proposed action were implemented, should be delineated; other alternatives, if possible, identified; and if appropriate, mitigation plans developed.

* Potential projects will not result in an average annual net loss of riparian habitat as compared to the future without project condition. Any project related loss of riparian habitat will be mitigated for on project lands.

* Consideration should be given to evaluating and preserving historical, archaeological, and other cultural resources.

5. Social Criteria

* Consideration should be given to safety, health, community cohesion, and social well-being.

* Displacement of people should be minimized to the extent practicable.

* Effects of a project on regional development, including income, employment, business and industrial activity, population distribution, and desirable community growth should be considered.

* The alternative plans should be workable within the constraints of present and potential future government structure, function, relationships, and associations in the study area.

C. Management Measures

Within the framework of plan formulation criteria, a wide variety of measures were identified to meet the planning objectives identified. The majority of the measures were eliminated from further consideration because they lacked economic justification, or didn't provide acceptable solutions. The measures that were retained provide the basis for formulating alternative plans. An action measure was considered throughout the planning process for comparative purposes. The following is a list of the various measures that were identified and considered as means for meeting the study objectives:

1. Flood Control Measures

a. Structural measures

- * Increase of channel capacity
- * Improvement of channel inlets
- * Reservoirs
- * Bypass channel
- * Bridge replacement

b. Nonstructural measures

- * Flood warning system
- * Floodwalls/floodproofing
- * Floodplain management
- * Flood emergency action plan
- * Relocation

2. Bank Protection Measures

- * Bank stabilization
- * Bypass channel
- * Reduce discharge velocity

3. Recreation Measures

- * Additional bike and pedestrian paths
- * Additional river access
- * Additional picnic sites
- * Additional active play areas

4. Fish and Wildlife Measures

- * Protection of existing resources from development
- * Mitigation of construction impacts
- * Public access to resource areas while protecting them

5. Cultural Resource Measures

- * Protection of known resources from development
- * Caution not to destroy undiscovered resources during development
- * Preconstruction testing to identify undiscovered resources

6. No Action Measure

Under this measure, the Federal Government would take no action to alleviate flood problems. The Nogales Wash-Potrero Creek Mainstream and its adjacent flood plains would not be altered for flood control works. Recreation potential and development would not be assisted by Federal flood control features and associated cost participation. Existing wildlife habitat would continue to be lost by erosion, local channel modifications, and land use change. This measure will be considered further in order to compare the effect of the alternative plans to conditions expected to occur with no Federal participation, and is synonymous with the without-project condition.

D. PLANS BY OTHERS

During the preparation of this Feasibility Report, coordination has been maintained with a number of government agencies who are responsible for implementing plans which may either address or impact the planning objectives of this study. The following project in the study area is currently under consideration:

Specific Canyon Wash Study by Arizona Department of Water Resources

The Arizona Department of Water Resources (ADWR) has prepared a feasibility phase report analyzing a flood control dam and discharge channel in Ephraim Canyon Wash, a tributary of Nogales Wash. The dam would store/release the incoming flood. The release would be discharged at the same rate that the existing 1-19 highway embankment releases it, and therefore would not have a significant effect on the peak discharges of the Nogales Wash/Potrero Creek mainstream. At this time, there is no assurance that this dam alternative will be implemented.

5.2.2. ANALYSIS OF FLOOD CONTROL MEASURES

The project team has designed to address specific problems in specific locations. Under this chapter, "plans" will be developed which are conceptual in nature that represent potential alternative actions.

The flood control study was conducted in two phases: the reconnaissance phase and the feasibility phase. Most of the measures were identified and evaluated at the reconnaissance level of detail in the reconnaissance phase. These were then screened on the basis of completeness, effectiveness, efficiency, and feasibility. Further screening, primarily at the reconnaissance level, was taken into the feasibility phase for detailed analysis.

Reconnaissance Phase

During the reconnaissance phase, the planning objectives were general and conceptual in nature (Chapter 1, Section 1.1). The study area was the entire flood plain within 10 miles of flood control; the objective was to reduce flood risk on the entire Canyon Wash/Potrero Creek mainstream (reaches 1-3). The reconnaissance phase of the reconnaissance phase analysis is a clear and concise, preliminary phase is further divided into two iterations.

a. First iteration

In the first iteration of the reconnaissance phase, the focus was on reducing flood damage in the United States, however, since approximately 48% of the study drainage area is in Mexico, the International Boundary was not considered as a constraint, and possible measures in Mexico were considered.

Table 15 illustrates the alternative measures investigated in the first iteration, their location by reach, their costs, annual costs, and annual benefits in terms of 1984 price levels, and the result of the investigation. Figure 8 illustrates the locations of these measures within the study area. Structural solutions investigated included dam and channel measures. Nonstructural solutions included a flood warning system, floodwalls, and relocations.

b. Second iteration

In December 1984, the U.S. Commissioner, International Boundary and Water Commission, United States and Mexico, advised the Los Angeles District Engineer (D.E.) that Mexico was not interested in joining in a study of flood control works in both countries. The second iteration was therefore used as a tool to modify measures based upon the International Boundary constraints. The second iteration also reanalyzed potential measures at Chula Vista including the upstream dams.

Table 16 illustrates the alternative measures investigated in the second iteration, their location by reach, their first costs, annual costs, annual benefits in terms of 1984 price levels, and the result of the investigation. Figure 9 illustrates the locations of these measures within the study area.

c. Reconnaissance phase recommendations

The reconnaissance phase identified three measures which showed potential for Federal interest (Table 17). They were the lateral collector channels, the Chula Vista channels, and channelization throughout the unimproved section (reach 4). A flood warning system had not been evaluated in terms of economic justification, however, it was determined that such a system should be further considered because of the system's potential for saving lives and reducing flood damages. The above measures will be described in detail in Section 2 of this chapter. It was decided that potential solutions in Mexico, including solutions which may have been economically justified, would not be studied in the feasibility phase.

Reconnaissance analysis indicated that there did not appear to be any significant potential project impacts on existing environmental resources. Analysis also indicated that there did not appear to be any potential (geotechnical) constraints that would prohibit development of the measures identified above.

2. Feasibility Phase

Justified reconnaissance phase plans were evaluated in detail in the feasibility phase. Also, as more technical information became available, additional measures were formulated and evaluated.

LEGEND

- |— NOGALES WASH STUDY AREA
- - - - - INTERNATIONAL BOUNDARY
- ...→ TRIBUTARIES SIGNIFICANT TO PROPOSED MEASURES

MEASURES EVALUATED

- ◀ DAMS
- DRAINAGE AREA CONTROLLED BY DAMS
- □ □ ADDITIONAL COVERED CHANNEL
- ▬ IMPROVED OPEN CHANNEL
- ▬ NEW OPEN CHANNEL
- - - - - NEW BYPASS CHANNEL

#

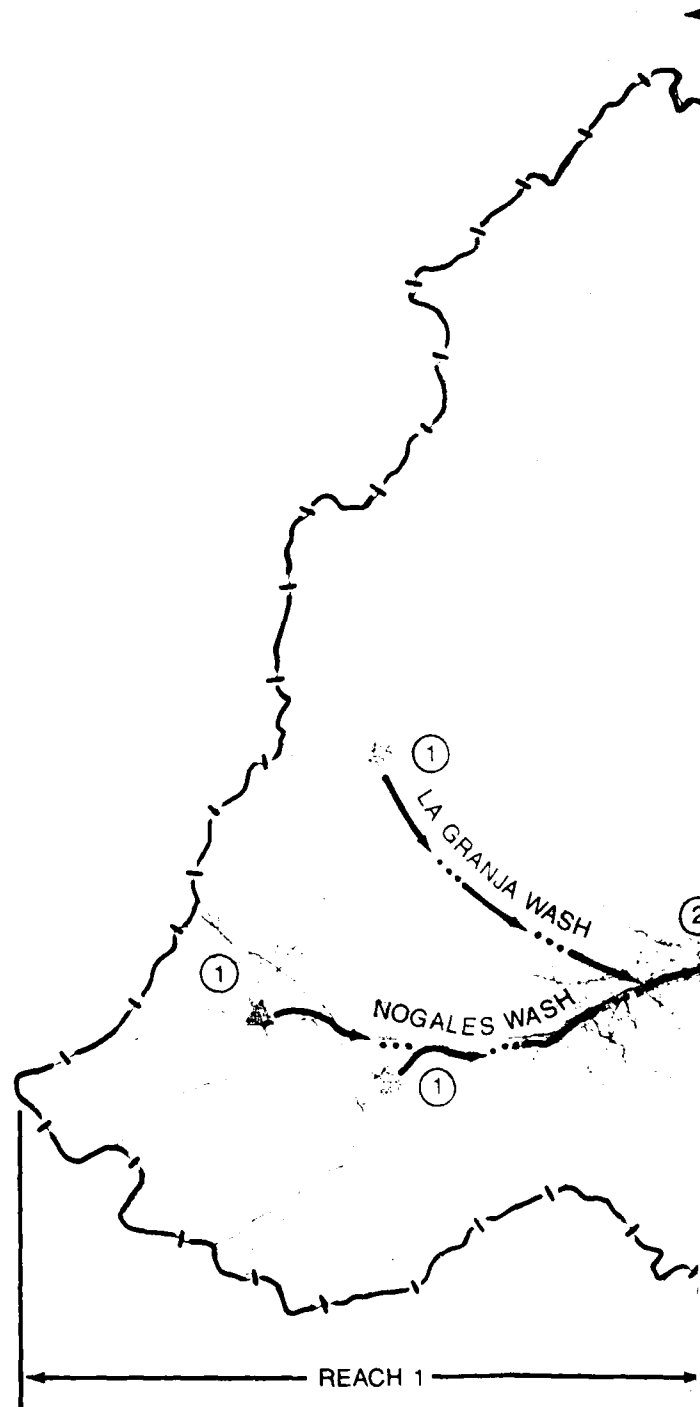
STRUCTURAL MEASURES

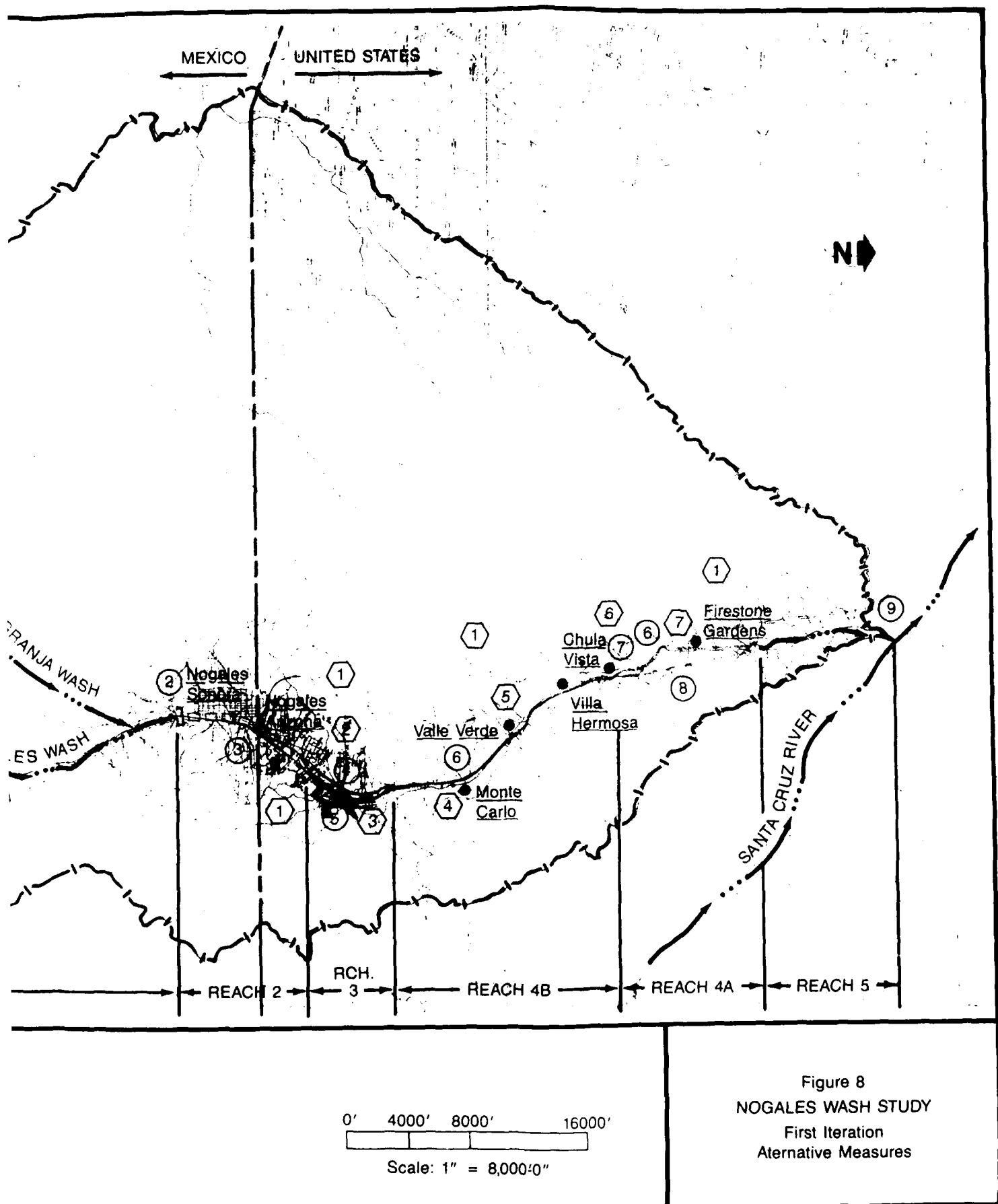
1. 3 DAMS IN MEXICO
2. IMPROVE MAIN INLET
3. ADDITIONAL COVERED CHANNEL
4. IMPROVE OPEN CHANNEL
5. RECONSTRUCT TWO BRIDGES
6. NEW OPEN CHANNEL
7. CHANNEL AT CHULA VISTA
8. BYPASS CHANNEL
9. LEVEE AT WASTE WATER TREATMENT PLANT

#

NON STRUCTURAL MEASURES

1. FLOOD WARNING SYSTEM
2. EPHRAIM CANYON FLOODWALL
3. RELOCATE SHERIFF STATION
4. RELOCATION AT MONTE CARLO
5. RELOCATION AT VALLE VERDE
6. RELOCATION AT CHULA VISTA AND VILLA HERMOSA
7. RELOCATION AT FIRESTONE GARDENS





LEGEND

- |— NOGALES WASH STUDY AREA
- - - - - INTERNATIONAL BOUNDARY
- ...→ TRIBUTARIES SIGNIFICANT TO PROPOSED MEASURES

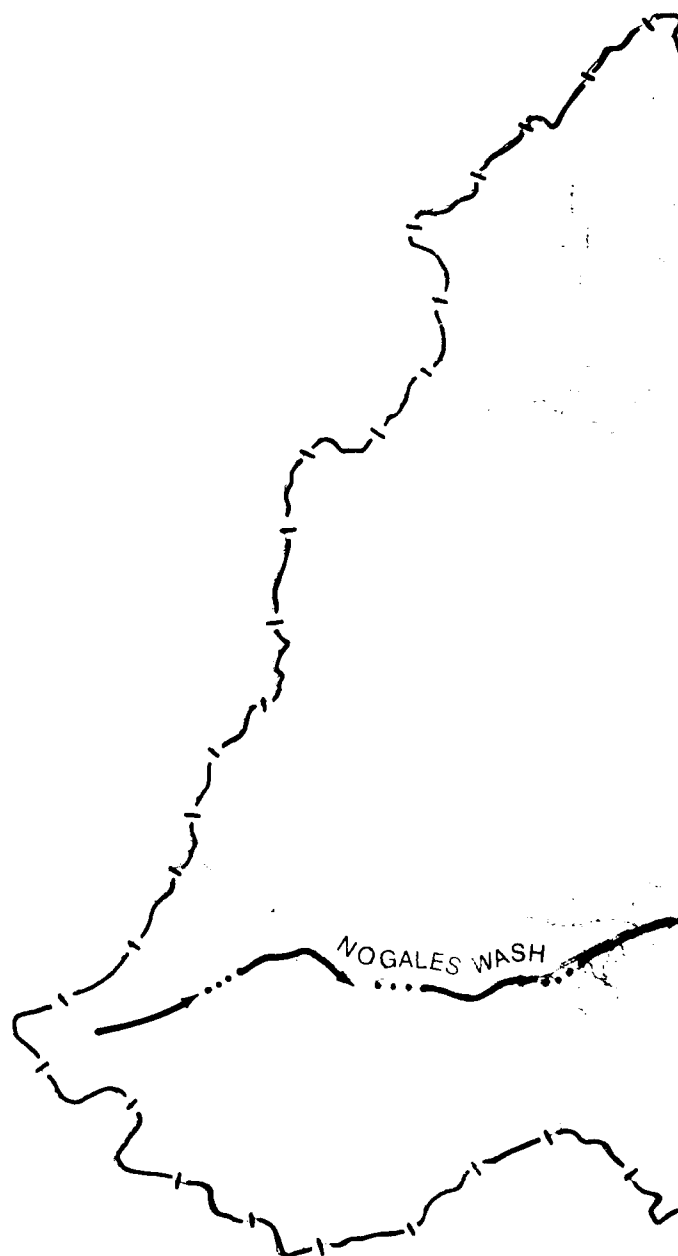
MEASURES EVALUATED

- ◀ DAMS (PROPOSED)
- DRAINAGE AREA CONTROLLED BY DAMS
- ▤ LATERAL COLLECTOR CHANNEL
- ||||| INCREASED CHANNEL CAPACITY RESULTING FROM LATERAL COLLECTOR CHANNEL
- NEW OPEN CHANNEL

#

STRUCTURAL MEASURES

1. LATERAL COLLECTOR CHANNEL
2. CHANNEL AT CHULA VISTA
3. POTRERO AND MARIPOSA CANYON DAMS



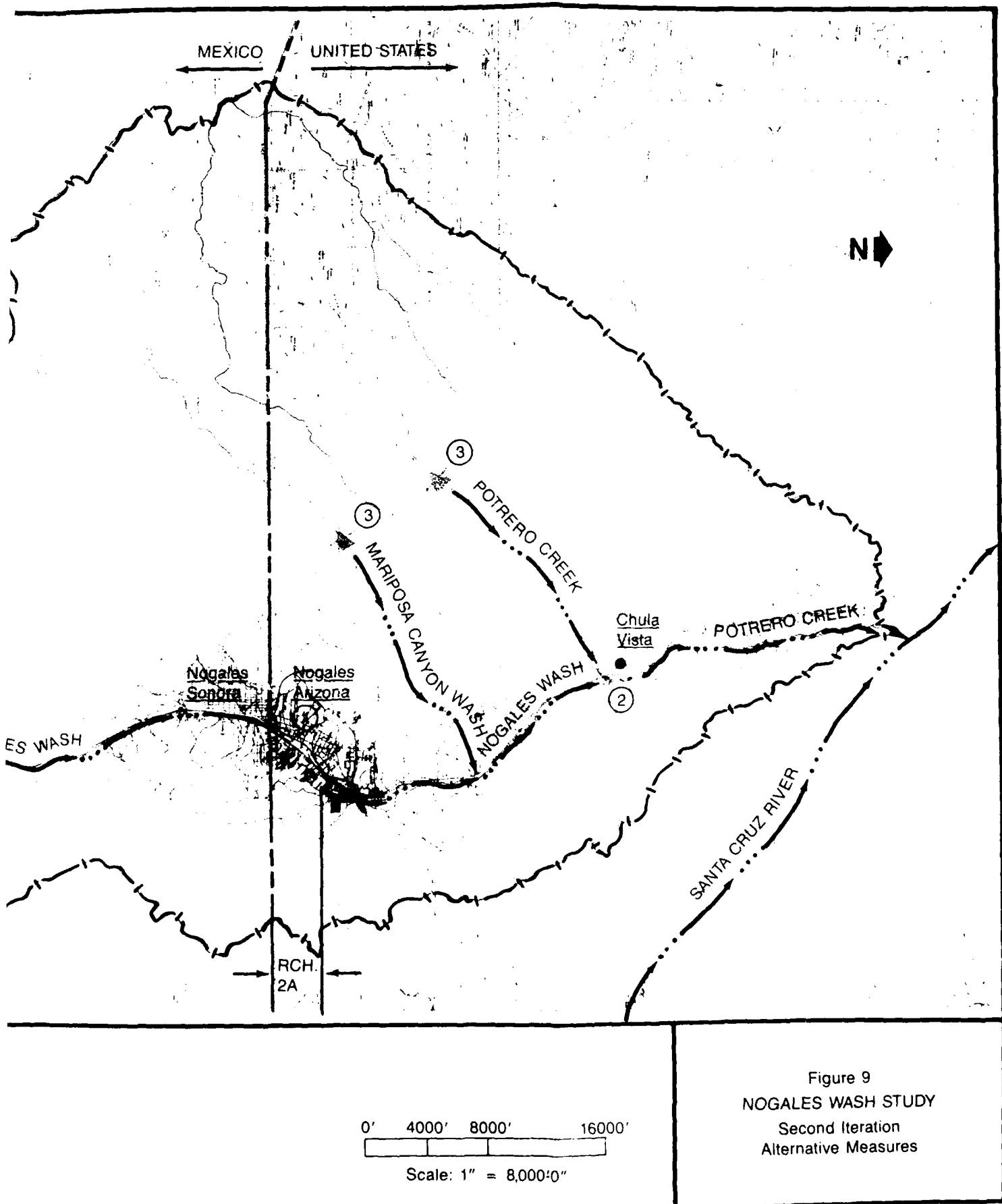


TABLE 15. Summary of First Iteration Alternative Measures (1984 Price Level & 1987)

TABLE 15. Summary of First Iteration Alternative Measures (cont.)
(1984 Price Level @ 8 1/8%)

Reactor 3					
International Waste Water Treatment Plant					
Construct Level					
50-year	1,043	100	13	0.15	Not Economically Justified. No Further Study Warranted.
100-year	1,659	157	17	.11	Not Economically Justified. No Further Study Warranted.
200-year	1,868	176	19	.11	Not Economically Justified. No Further Study Warranted.
500-year	2,510	240	21	0.11	Not Economically Justified. No Further Study Warranted.

NON-STRUCTURAL ALTERNATIVES

Measures	Estimated Damage System				Further detailed study warranted.
1. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
2. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
3. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
4. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
5. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
6. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
7. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
8. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
9. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
10. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
11. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
12. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
13. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
14. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
15. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
16. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
17. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
18. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
19. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.
20. Structural damage	400' Floodwall for 20' Impact Buildings	454	47	.10	Not Economically Justified. No Further Study Warranted.

TABLE 16. Summary of Second Iteration Alternative Measures
(1984 Price Levels @ 8 1/8%)

Watercourse/site	Improvement Considered	First Cost (\$x1000)	Annual Costs (\$x1000)	Annual Benefits (\$x1000)	Benefit Cost Ratio	Findings/Recommendations
Reach 2A						
*International Boundary	Lateral Collector Channel	1000	93	225	2.42	Further detailed study warranted.
Reach 4						
*Chula Vista	Chula Vista Channels (Protect Chula Vista Only)					
	100-year	4010	383	454	1.18	Further detailed study warranted.
	Chula Vista Channels (Protect Chula Vista and Other Vacant Land)					
	100-year	4863	439	498	1.13	Further detailed study warranted.
*Potrero Creek/Mariposa Canyon Wash (Figures are for each location; not both)						
	Single Purpose Flood Control Dam	6350	546	54	0.10	Not economically justified. No further study warranted.
	Flood Control and Water Supply Dam	6350	580	214	0.37	Not economically justified. No further study warranted.
	Single Purpose Water Supply Dam	5000	460	160	0.34	Not economically justified. No further study warranted.

Table 17. Summary of Reconnaissance Phase Measures
Having Federal Interest

Watercourse/site	Improvement Considered	First Cost (\$x1000)	Annual Costs (\$x1000)	Annual Benefits (\$x1000)	Benefit Cost Ratio
Reach 2A					
International Boundary	Lateral Collector Channel	1000	93	225	2.42
Reach 4					
Entire Reach	Construct 50-year Earth Bottom Channel	17037	1585	1599	1.01
Chula Vista Only	Construct Channel	4010	383	454	1.18
Chula Vista and Adjacent Lands	Construct Channel	4863	439	498	1.13
Reach 4B Only					
	Construct 50-year Earth Bottom Channel	858	83	185	2.23
	Construct 100-year Earth Bottom Channel	915	88	208	2.36
	Construct 200-year Earth Bottom Channel	1008	96	224	2.33
	Construct 500-year Earth Bottom Channel	1183	112	230	2.05

The feasibility phase was also accomplished with two iterations. The first of these, or "third iteration" was focused on finalizing an array of alternative measures that would assist in solving water resource problems and identifying the NED level of protection. The final array would then be taken into the "fourth iteration" where more detailed designs were developed.

Based on the reconnaissance findings, the feasibility phase focused on problems related to specific sites. Efforts were concentrated on areas affected by the lateral collector channel, improvements throughout the unimproved section (reach 4), and the Chula Vista Channels (reach 4-5).

It was determined that a detailed hydrologic analysis would be needed for with and without project, present and future conditions (see Tables 12A thru 12 D in Chapter III). Hydrologic Concentration Points (C.P.s) were selected to analyze the efforts of the major tributaries (see Plate 1) and to complement the forthcoming economic analysis. In the feasibility phase, without project hydraulic analysis focused on flow distribution at the border, reevaluation of the existing channel capacities in Reach 4 to include that of Potrero Creek just upstream of the Chula Vista community, the determination of the nondamaging flow frequencies, the significance of the Valle Verde breakout, and the bank erosion problem in the unimproved section downstream of Chula Vista (reach 4A). Hydraulic analysis focused on hydraulic design, potential sediment transport problems, interior drainage, and the evaluation of with project overflows.

The feasibility phase economic analysis focused on the covered concrete channel section in the U.S. (reach 2A), and the entire length of the unimproved section (reach 4). Further analysis was not conducted in Mexico (reaches 1 and 2B) since solutions there were no longer to be considered. No further economic analysis was conducted in the open concrete channel section (reach 3) or in the downstream section (reach 5) since solutions affecting these areas were found not to be justified in the reconnaissance phase.

a. Third iteration

Figure 10, illustrates the measures evaluated in the third iteration. Figures 11 through 15 are schematic illustrations of the without and with (35-yr. future condition) project lateral collector channels. Figures 16 through 19 are schematic illustrations of the without and with (100-yr. future condition) project Chula Vista channels.

* LATERAL COLLECTOR CHANNELS



The reconnaissance phase led to the development of the lateral collector channel (LCC) system. Conceptually, two LCCs would be constructed just north of the International Boundary and would capture overland street flow coming from Mexico. The LCCs would then put this flow into the existing unfilled covered channel system. The without project condition is illustrated in Figures 11 and 12.

In the reconnaissance phase, the LCCs developed as open concrete channels aligned perpendicular to the overland flow (Figure 15). They would be constructed on the U.S. side of the boundary from valley wall to valley wall and would hydraulically tie into two existing covered channels. The Nogales Wash covered channel (NWCC) is located on the east side of the valley and runs under Robbins Avenue. The Arroyo Boulevard covered channel (ABCC) starts at the border and is located on the west side of the valley under Arroyo Boulevard. The Southern Pacific railroad runs down the center of the valley and to some degree is a barrier which divides the street flow on one side, from

LEGEND

- |— NOGALES WASH STUDY AREA
- INTERNATIONAL BOUNDARY
- ...→ TRIBUTARIES SIGNIFICANT TO PROPOSED MEASURES

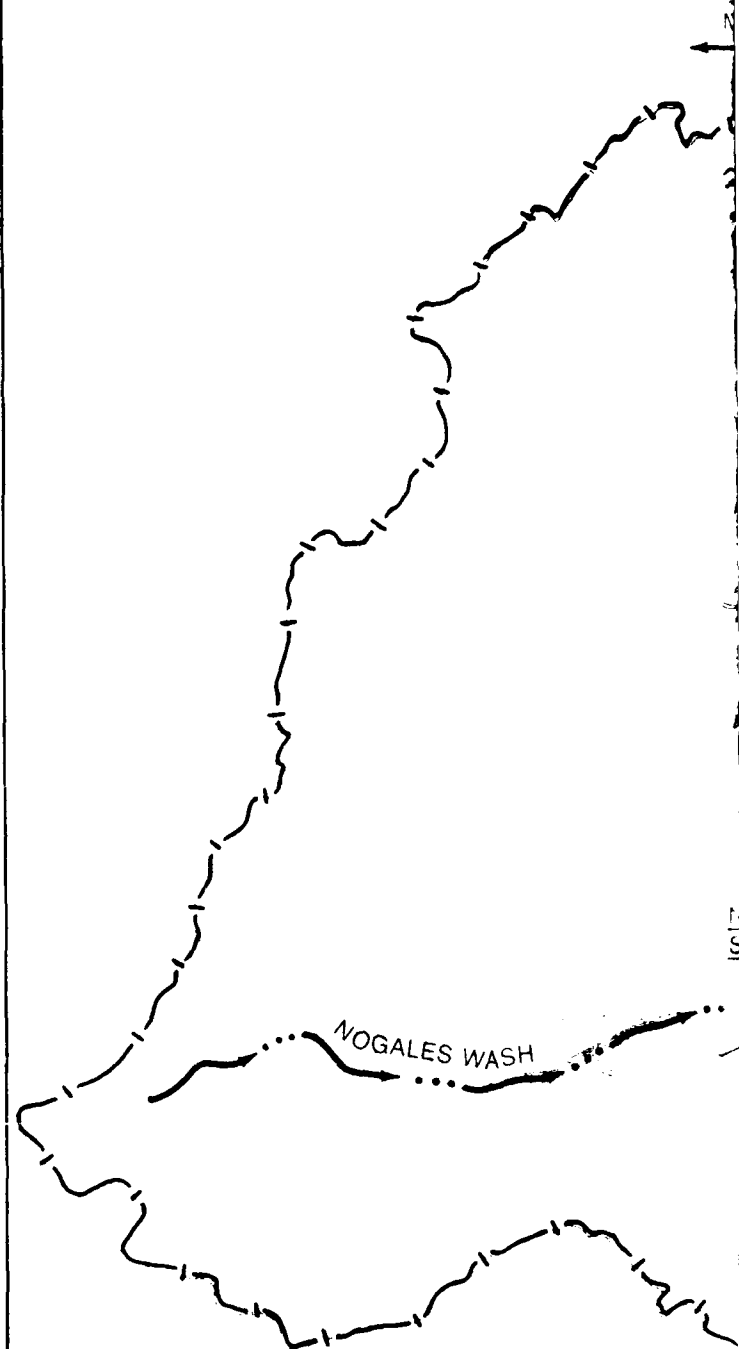
MEASURES EVALUATED

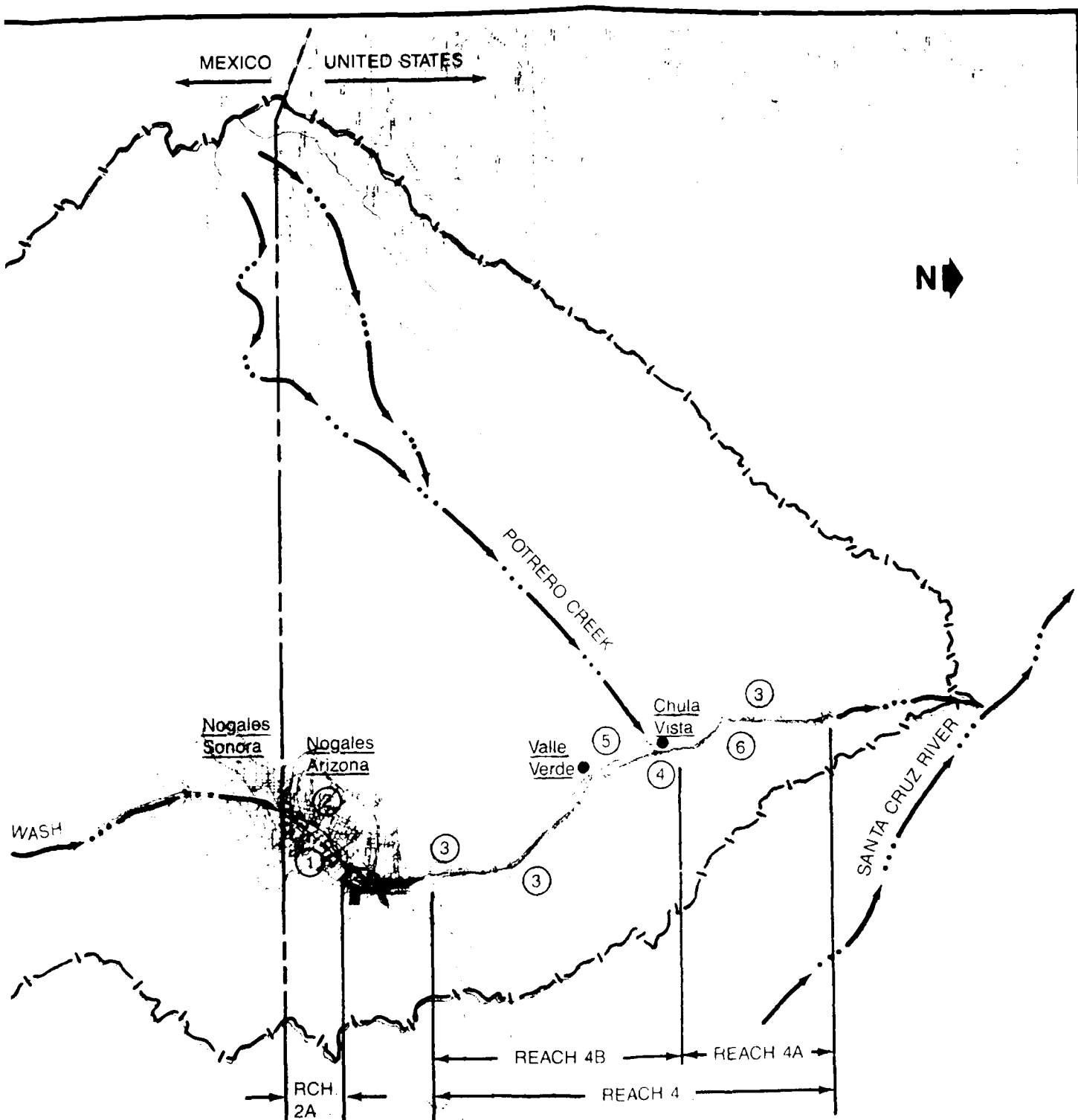
-  LATERAL COLLECTOR CHANNEL
-  INCREASED CHANNEL CAPACITY RESULTING FROM LATERAL COLLECTOR CHANNEL
- ADDITIONAL COVERED CHANNEL
- NEW OPEN CHANNEL
- OVERBANK CHANNEL
- BANK PROTECTION

#

STRUCTURAL MEASURES

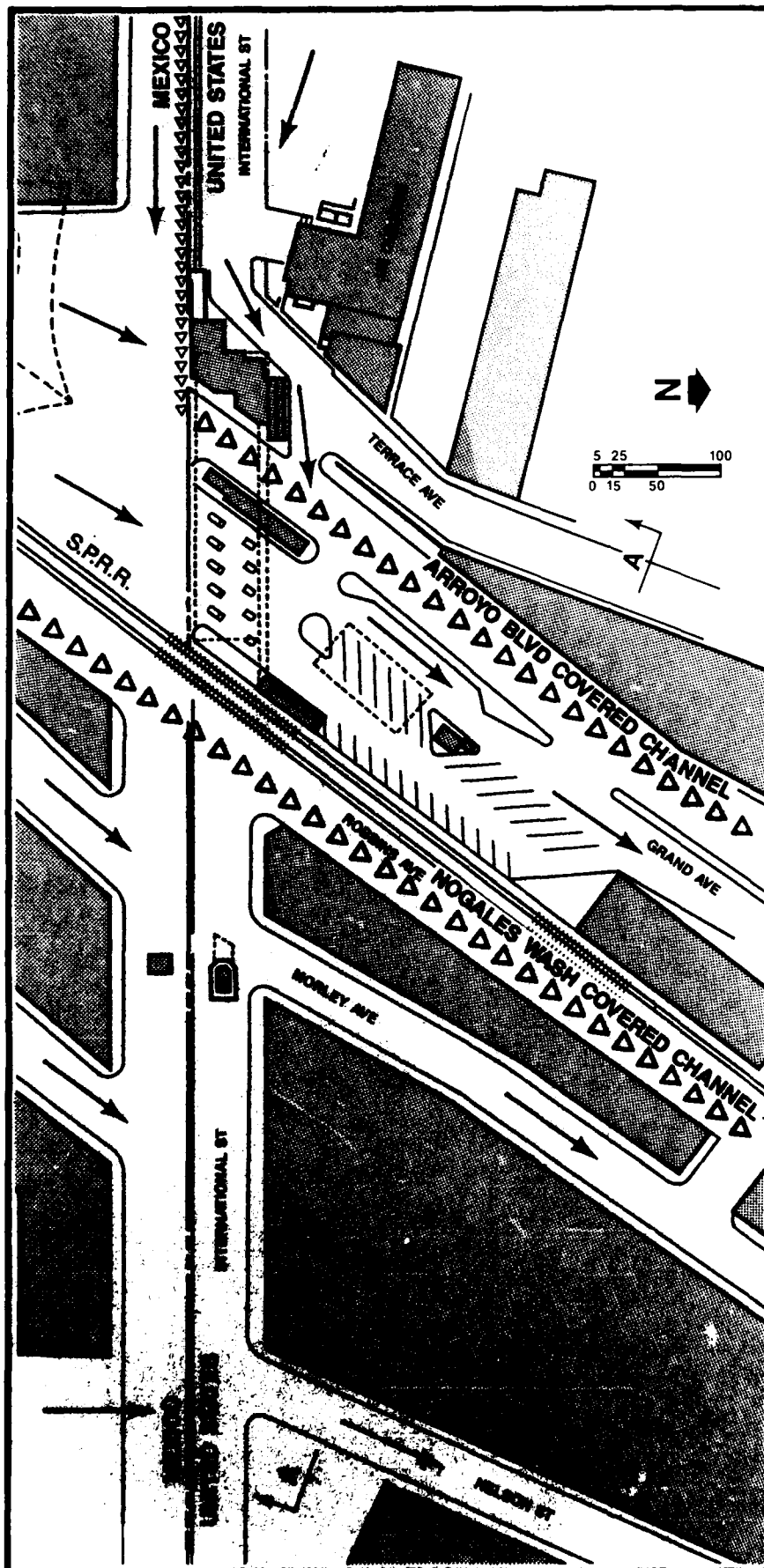
1. LATERAL COLLECTOR CHANNEL
2. ADDITIONAL COVERED CHANNEL
3. OPEN CHANNEL IN REACH 4
4. CHULA VISTA CHANNEL
5. VALLE VERDE OVERBANK CHANNEL
6. BANK PROTECTION IN REACH 4A





0' 4000' 8000' 16000'
 Scale: 1" = 8,000'0"

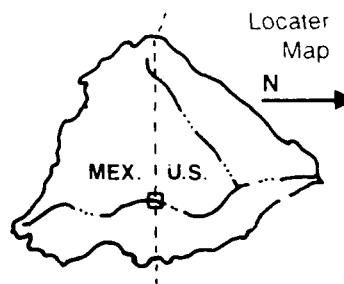
Figure 10
 NOGALES WASH STUDY
 Third Iteration
 Alternative Measures



LEGEND

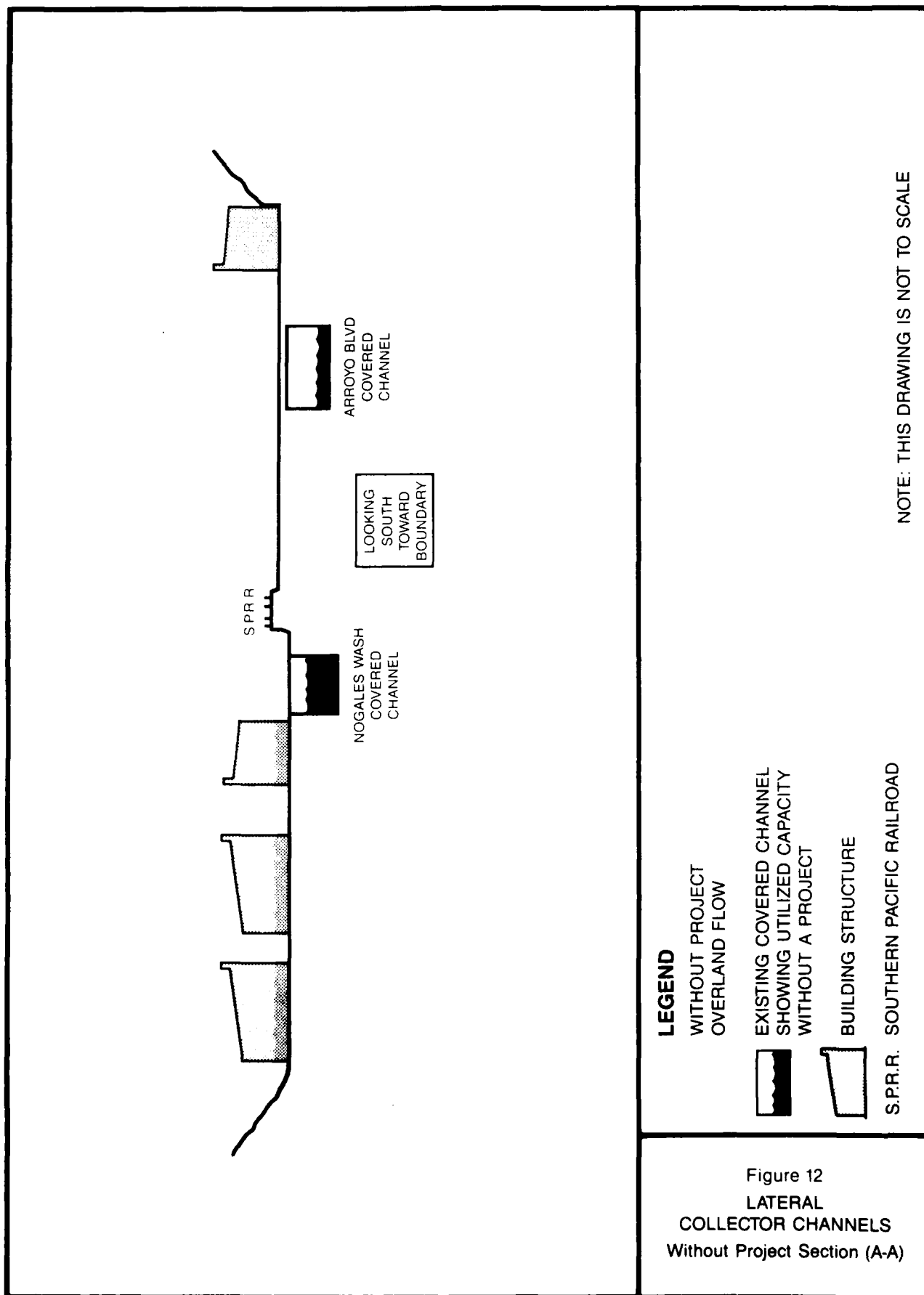
- INTERNATIONAL BOUNDARY
- WITHOUT PROJECT OVERFLOW
- DIRECTION OF OVERLAND FLOW
- ▷▷▷ EXISTING UNFILLED COVERED CHANNELS
- ▭ BUILDING STRUCTURES
- S.P.R.R. SOUTHERN PACIFIC RAILROAD

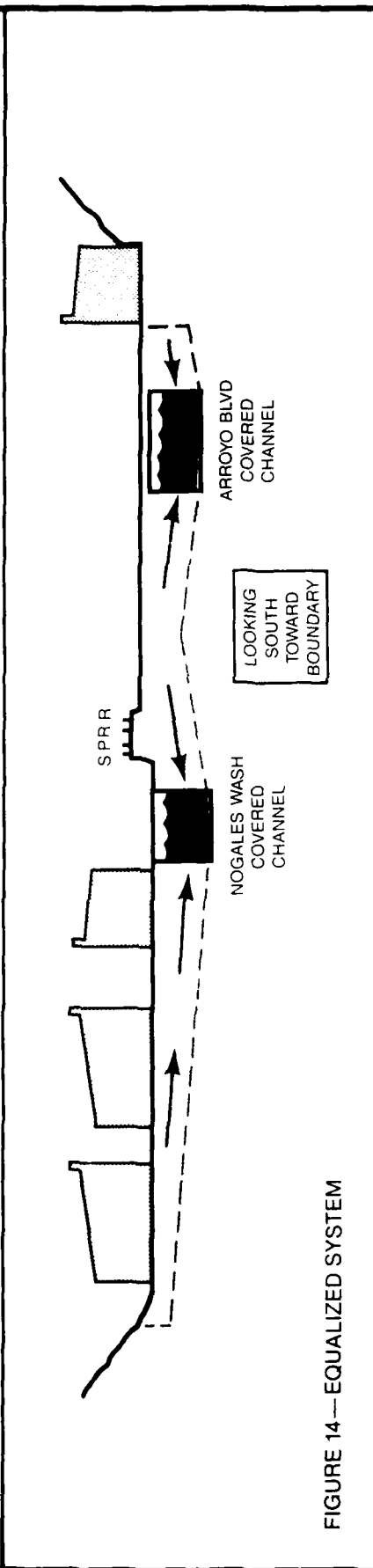
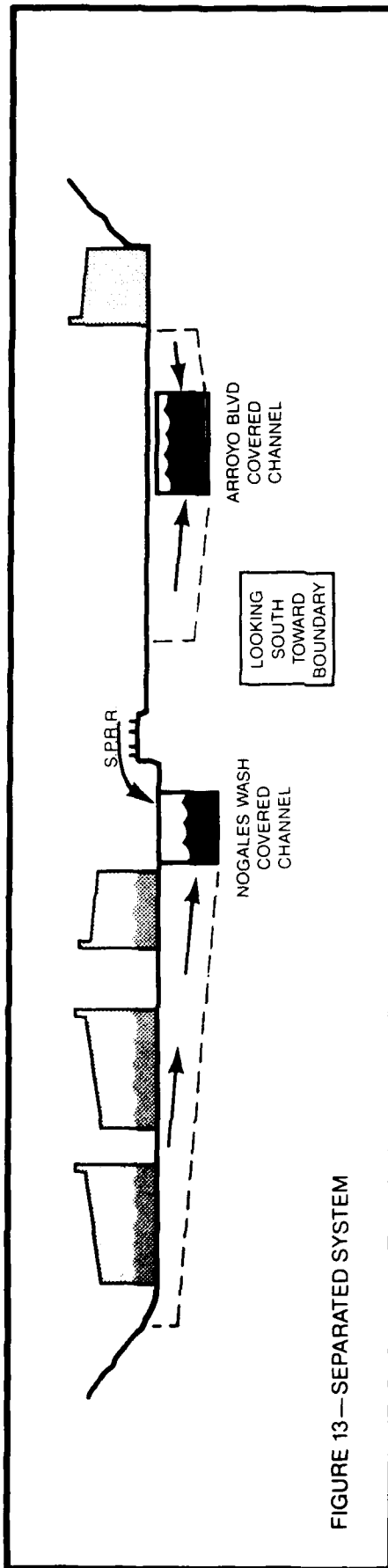
SECTION (AA) SEE FIGURE 12







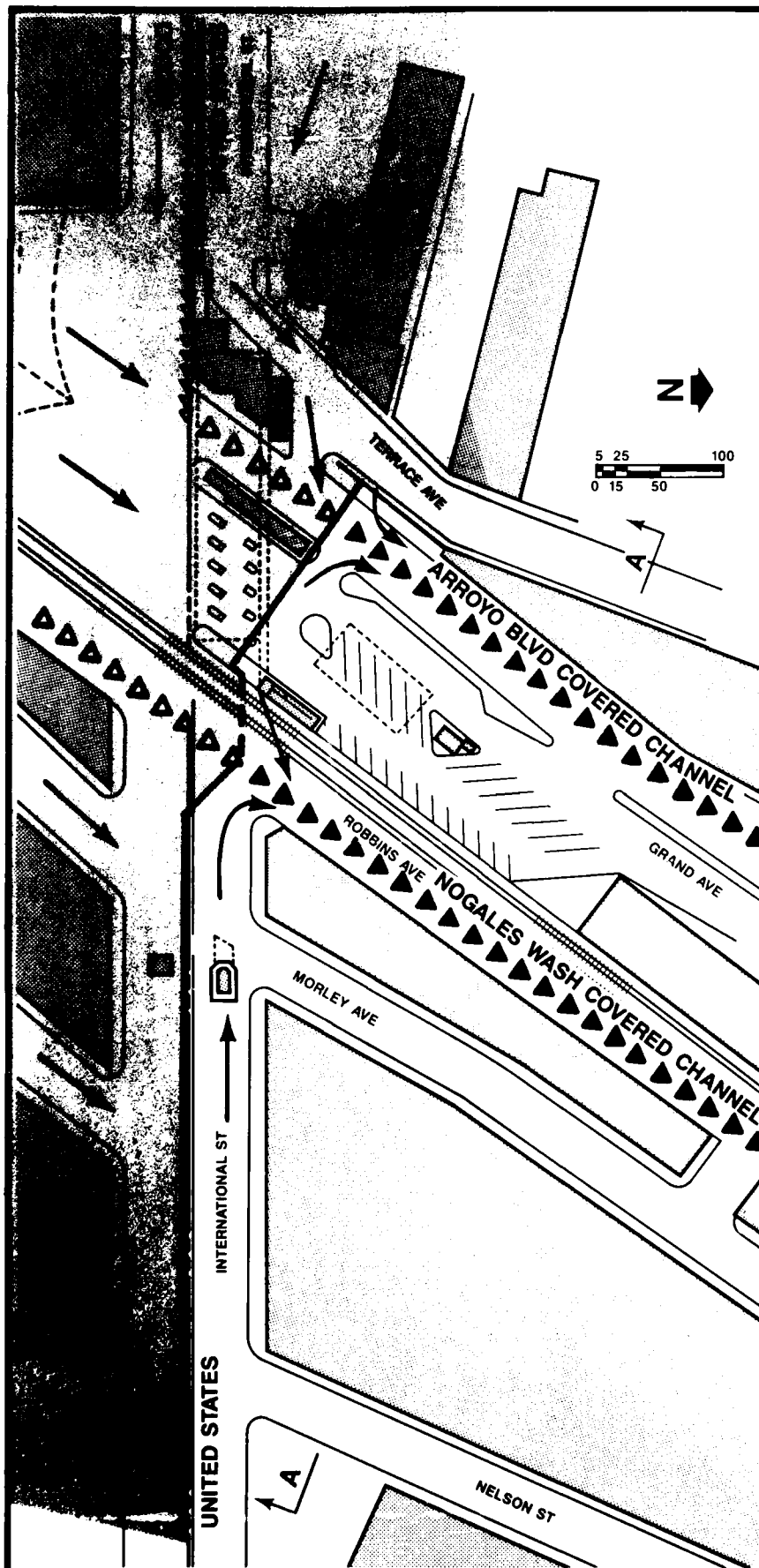
NOTE: THIS DRAWING IS NOT TO SCALE

Figure 11
LATERAL COLLECTOR
CHANNEL
Without Project Plan





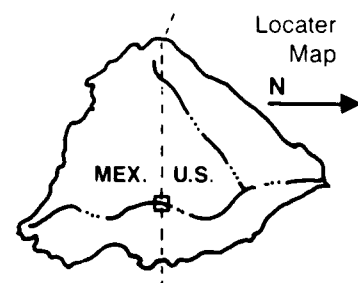
<p>Figure 13 & 14 LATERAL COLLECTOR CHANNELS With Project Section (A-A)</p>	<p>LEGEND</p> <div style="display: flex; justify-content: space-around;"> <div>  <p>EXISTING COVERED CHANNEL SHOWING UTILIZED CAPACITY WITH A PROJECT</p> </div> <div>  <p>BUILDING STRUCTURE</p> </div> </div> <div style="display: flex; justify-content: space-around;"> <div>  <p>S.P.R.R. SOUTHERN PACIFIC RAILROAD</p> </div> <div>  <p>LATERAL COLLECTOR CHANNEL AND FLOW INDICATOR</p> </div> </div> <p style="text-align: right;">NOTE: THESE DRAWINGS ARE NOT TO SCALE</p>
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LEGEND

- INTERNATIONAL BOUNDARY
- WITH PROJECT OVERFLOW
- FLOW INDICATOR
- ▷▷▷ EXISTING UNFILLED COVERED CHANNELS
- ▲▲▲ EXISTING COVERED CHANNELS FILLED BY LATERAL COLLECTOR CHANNEL
- LATERAL COLLECTOR CHANNEL
- EQUALIZER CHANNEL
- BUILDING STRUCTURES

SECTION (A-A),
SEE FIGURE 13 & 14



NOTE: THIS DRAWING IS
NOT TO SCALE

Figure 15
LATERAL COLLECTOR
CHANNEL
With Project Plan

that on the other side. The combined controlling capacity of both covered channels was determined to be 7650 cfs. If both covered channels could be filled to capacity, a 33-year future level of protection would be provided. In the reconnaissance phase, it was thought that if two separate collectors were utilized, the NWCC would be filled and result in flood damage east of the Southern Pacific Railroad (SPRR), while the ABCC would still be unfilled (Figure 13). By connecting the two collectors with an "equalizer channel", both existing covered channels could be filled before additional street flooding would occur (Figure 14).

At the beginning of the feasibility phase a reevaluation of the overland flow distribution at the International Boundary was conducted in detail to determine the required collecting capacity for both pieces (east and west) of the lateral collector channel (LCC) system and to determine the required capacity and direction of flow for the equalizer channel between the two pieces. The reanalysis found that the majority of the overland flow at the border would come across on the west side of the railroad tracks. It was found that only a small amount would actually cross the border east of the tracks (113 cfs or 8% of the total 1410 cfs overland flow for the 20-year future condition flood, and 127 cfs or 1.5% of the total 8300 cfs overland flow for the 100-year future condition flood). This illustrates that the total collecting capability on the east side would be relatively small (between 110 cfs and 130 cfs). Conversely, the majority of the overland flow would cross the border on the west side of the tracks and the collecting capability on that side would have to be relatively larger (1300 cfs for the 20-year future condition flood, and 8172 cfs for the 100-year future condition flood). This analysis changed the reconnaissance phase concept that the Nogales Channel (NWCC) would be filled first and that an equalizer channel would take additional flows to the Arroyo Boulevard channel (ABCC) as was illustrated in Figure 14. With the new data, it was determined that ABCC would be filled first and additional flow would be directed to the NWCC. Without a hydraulically balanced system, additional flooding would occur on both sides of the valley from floods larger than 30-year (future condition) even though there would still be available capacity in the NWCC. Figures 13 and 14 illustrate schematic cross section of the two separate, and a balanced LCC system. Figure 15 illustrates a plan view of the balanced LCC system. This change significantly affected both the without and with project benefit analysis as can be seen by comparing the benefits in Table 16 to Table 18.

Plans of the LCC system were also developed with lower levels of protection (20 and 28-year future condition hydrology). The results of the analysis are illustrated in Table 18. The net benefits were largest for the 33-year future condition LCC system and as such it was identified as the National Economic Development (NED) level of protection.

Because of the dramatic increase in potential project benefits in the covered channel section (reach 2A), it was determined that a reanalysis should be made of the potential for increasing the total channel capacity in that reach.

* ADDITIONAL COVERED CHANNEL WITH LATERAL COLLECTOR CHANNEL

It had been determined in the reconnaissance phase that the construction of additional covered channel would be the least costly and most reasonable means

to increase channel capacity in reach 2A. The most likely alignment for additional covered channel was determined to be the Grand Avenue roadway alignment. This would provide reasonable width and is also located in the west valley where the majority of the overland flows occur.

Plans were developed to provide 50, 100, and 200-year (future condition) levels of protection throughout reach 2A (levels less than 33-year would not require additional covered channel). The outlet to the proposed Grand Avenue covered channel (GACC) would be located near the outlet of the Arroyo Boulevard covered channel (ABCC). It was assumed that the proposed improvements in Reach 2A would have no impacts in reaches downstream (Reaches 3, 4, and 5). The economic results of this analysis are illustrated in Table 18.

The economic analysis of the 50, 100, and 200-year LCC and additional covered channel system showed that all three plans as a whole were justified; however, the net benefits were not as great as for the 33-year LCC. This indicates that the additional covered channel would not be incrementally justified.

In the analysis of the LCC system, it was assumed that the four existing inlets to the covered channel system would remain in the same condition as they are at present (1987). A sensitivity analysis was performed in the third iteration to determine what potential effect that inlet condition changes might have on the various LCC plans. Four scenarios were developed. They were (1) all inlets remain as they are at present (2) all inlets become 100% plugged (3) all inlets become 100% clean and clear, and (4) measures are constructed in Mexico which would hydraulically fill the existing covered channels there. Table 19 illustrates the results of this analysis. The analysis considered various levels of protection from 20-year to 200-year (future condition). The sensitivity analysis found that for the first three scenarios, the LCCs would be justified and the 33-year level of protection would be the NEB. In the fourth scenario, there would still be the same net flood reduction benefits to the Arizona community except that they would be provided by measures constructed in Mexico.

* CHANNELIZATION IN REACH 4

In the reconnaissance phase, it was concluded that additional analysis would be required to determine whether there would be a justified comprehensive channel solution in the unimproved section (reach 4). It was known in the second iteration that there was a significant breakout of Nogales Wash in the Valle Verde community (see Figure 7); however, the channel capacity of Nogales Wash at that location, the nondamaging frequency, and the impacts of the increased discharge frequency values, needed to be evaluated.

In order to evaluate the potential benefits in the unimproved section, reach 4 was broken up into seven economic subreaches (Plate 3). The purpose of this was to separate higher damage areas from lower damage areas. For example, it was presumed that Chula Vista and Valle Verde (Subreaches 4-3 and 4-5) were both high damage areas because they were developed and there were breakouts at both locations. On the other hand, the area in between the two communities (Subreach 4-4) is relatively undeveloped and would not provide many economic benefits. With the development of subreaches in reach 4, and the resulting benefit assessment of the subreaches (Table 20), the study team reanalyzed the

potential for channelization throughout the unimproved section. The calculated annual benefits for the 20, 50, and 100-year channels were converted into adjusted present values using an amortization rate of 8 7/8% and October 1986 price index. This value indicated the maximum construction costs that would result in an economically justified project for any particular level of protection. The results of this analysis indicated that in terms of channelization, only subreach 5 (Chula Vista) would be economically justified.

* VALLE VERDE OVERBANK CHANNEL

As a result of the above Reach 4 economic analysis, it was determined that channelization in the Valle Verde subreach would not be incrementally justified. Another type of solution was developed, however, to reduce flood damage to the Valle Verde community (Figure 10). It was named the Valley Verde Overbank Channel (VVOC). This solution would consist of a flood wall running along the east shoulder of U.S. Highway 89 east of the Valle Verde community. The floodwall would eliminate the breakout of Nogales Wash into Valle Verde up to the design level of protection. It would, however, raise the flood stage east of the floodwall. The structures east of the proposed VVOC are produce transfer warehouses which have floor elevations four to five feet higher than the ground elevation, so it was assumed that flood damages would be minimal up to that raised floor elevation.

Initially, benefits for the VVOC were calculated at the 10, 25, 50, and 100-year levels of protection without considering any loss of benefits for potential induced damages on the east side of the floodwall. The economic findings showed that the 10 and 25-year plans would not be economically justified, but the 50 and 100-year plans showed potential for economic justification. These larger protection levels, however, would inundate buildings (above dock height) in the east valley that otherwise would not get flooded even in a standard project flood. It was found that the net result of the induced damage would reduce benefits so that the 50 and 100-year VVOC would no longer be justified. For these reasons all VVOC plans were dropped from further consideration.

* CHULA VISTA CHANNELS

Continued analysis of the Chula Vista channels focused on the hydraulic problem of eliminating flood flow from three different sources (Nogales Wash breakout, Valle Verde breakout, and Potrero Creek breakout). Figures 16 and 17 illustrate the without project condition. Many conceptual plans were analyzed for this reason.

It was determined that the most economical approach to the problem would be to divert all flood waters into Nogales Wash upstream or south of Chula Vista. An interceptor channel would carry Potrero Creek eastward to a new confluence with Nogales Wash (Figures 18 and 19). The breakouts of Nogales Wash above Chula Vista and at Valle Verde would also be captured by this interceptor channel and conveyed to the new confluence. The combined flows would then be conveyed along the east side of Chula Vista in an enlarged channel. It was also determined that the cost of the interceptor channel could be reduced by tying it into a knoll just southwest of Chula Vista rather than the U.S. Highway 89 bridge as was originally considered. This concept also

eliminated certain negative environmental impacts associated with the bridge connection.

It was determined that a totally entrenched interceptor channel large enough to contain the entire design flow would not be economically justified. As a result, alternatives were developed that would utilize a berm or levee on the north side of the interceptor channel, to help contain the flow. This channel/levee concept became known as the Chula Vista/Potrero Interceptor Channel (CVPIC) and was designed as a trapezoidal earth bottomed section.

The enlarged Nogales Wash channel was designed as a rectangular concrete section, because of the limited rights-of-way between the Old Tucson Highway and the Southern Pacific Railroad embankment, and for the purpose of minimizing the spans of two required bridges. It was determined that an energy dissipator would be required to reduce the velocity of the water at the downstream end of the project.

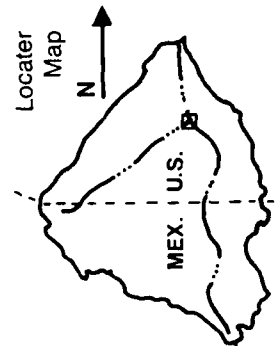
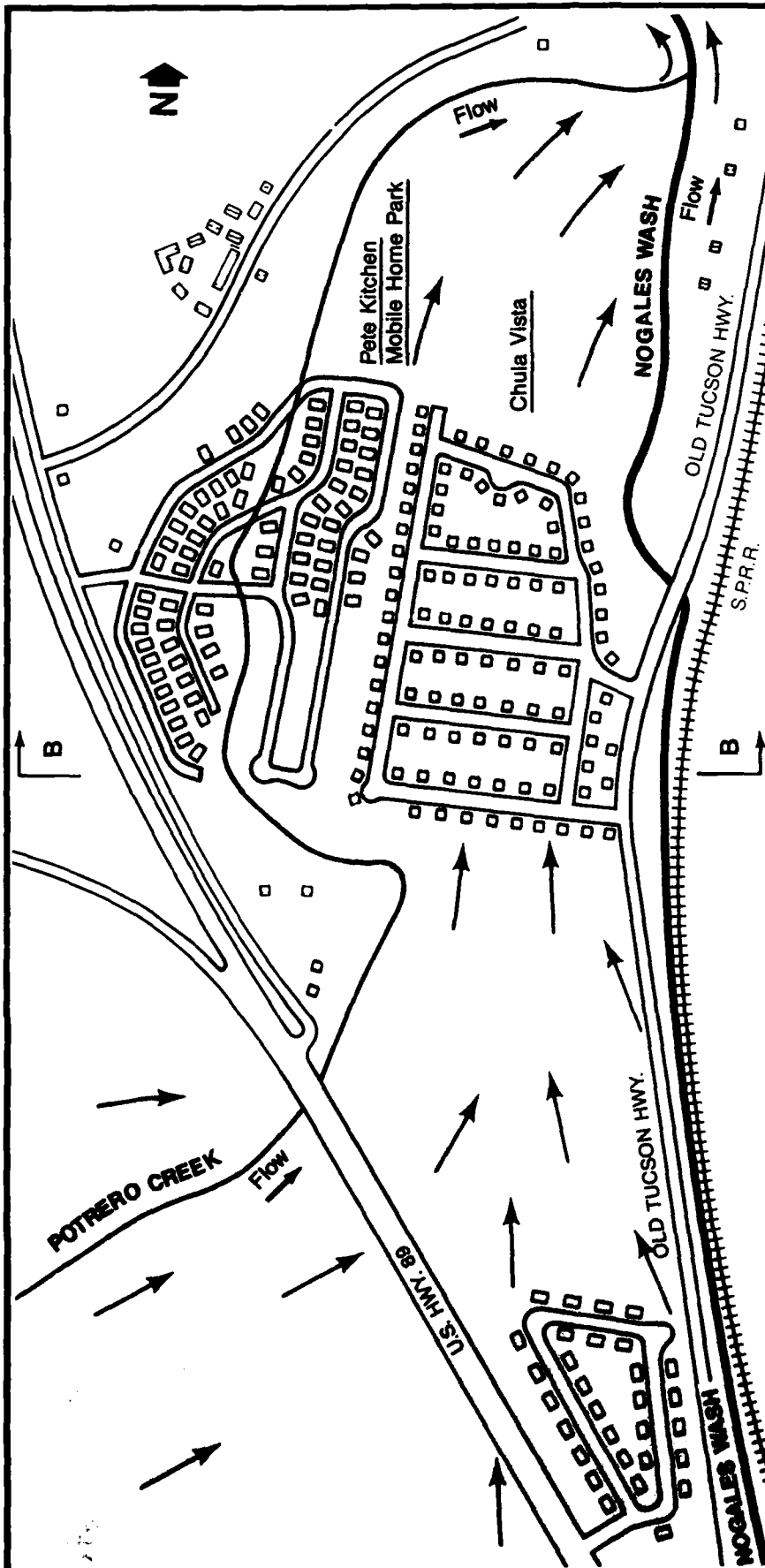
Costs and benefits for the Chula Vista Channel System were developed for the 5, 10, 20, 50, and 100-year (future condition) plans. The NED appeared to be the 20-year level, however, the 100-year net benefits were just slightly less. Table 18 illustrates the economic results of the various plans.

* BANK PROTECTION IN REACH 4A

As was described in Chapter III, Section C, bank erosion is a significant problem in Reach 4A. In the third iteration, this problem was analyzed to determine the extent of past erosion, the most probable locations of future erosion, the extent of existing and potential land development on lands that are subject to erosion, and the potential economic benefits which may be achieved with a bank protection alternative.

Analysis found that approximately 50% of the lands that are subject to erosion, are not developed at this time. Analysis also found that those lands subject to bank erosion are typically located within the Federal Emergency Management Agency (FEMA) floodway. As such, FEMA regulation would prevent development of these lands even if they were protected from future bank erosion. The only way to make these lands developable would be to increase the channel capacity to a level where they would be removed from the floodway. Again, this was determined not to be economically justified, even when the resulting "location benefits" were included.

During the course of this study, the U.S. Soil Conservation Service (SCS) installed two lines of Kellner jacks in hopes of stopping the erosion at two locations near Firestone Gardens (see Figure 4). To date, these lines seem to be effective. Sediment is being deposited and vegetation is growing between the jacks and the bank line. The installation of the jack lines will undoubtedly change the projected erosion rates that were determined in the Corps analysis. Due to the fact that 1) the future effects of the jack lines are unknown at this time, 2) preliminary analysis indicates that traditional bank protection measures would not be economically justified, and 3) the Soil Conservation Service is working toward solving the erosion problem in the study area, it was determined that this study would not continue with analysis of the erosion problems. At the time of this report the Soil Conservation Service is not investigating other bank erosion problems along Nogales Wash or Potrero



SECTION (B-B), SEE FIGURE 17

LEGEND

WITHOUT PROJECT
OVERFLOW

EXISTING WATER
COURSES

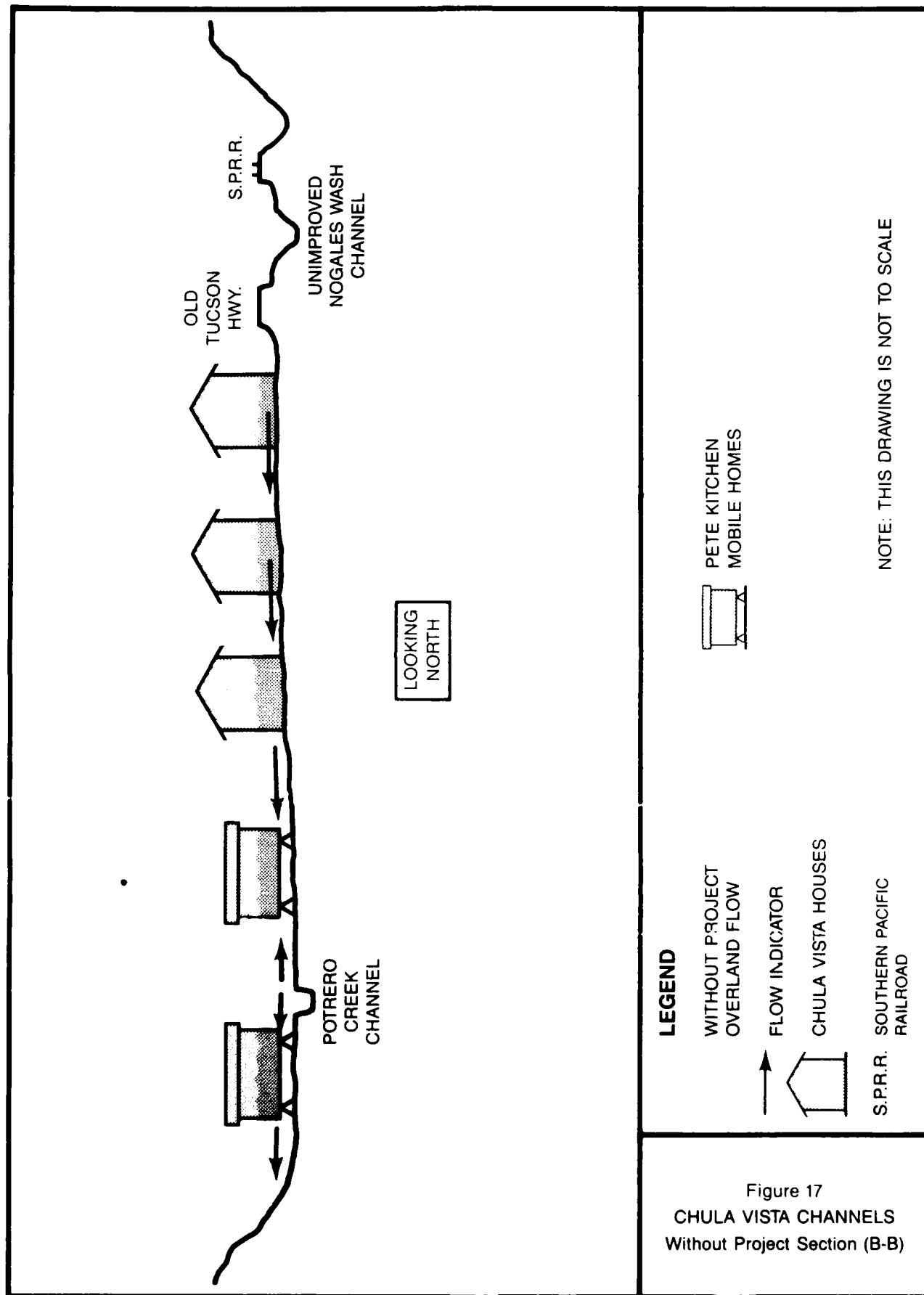
DIRECTION OF
OVERLAND FLOW

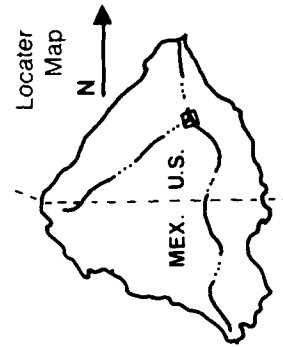
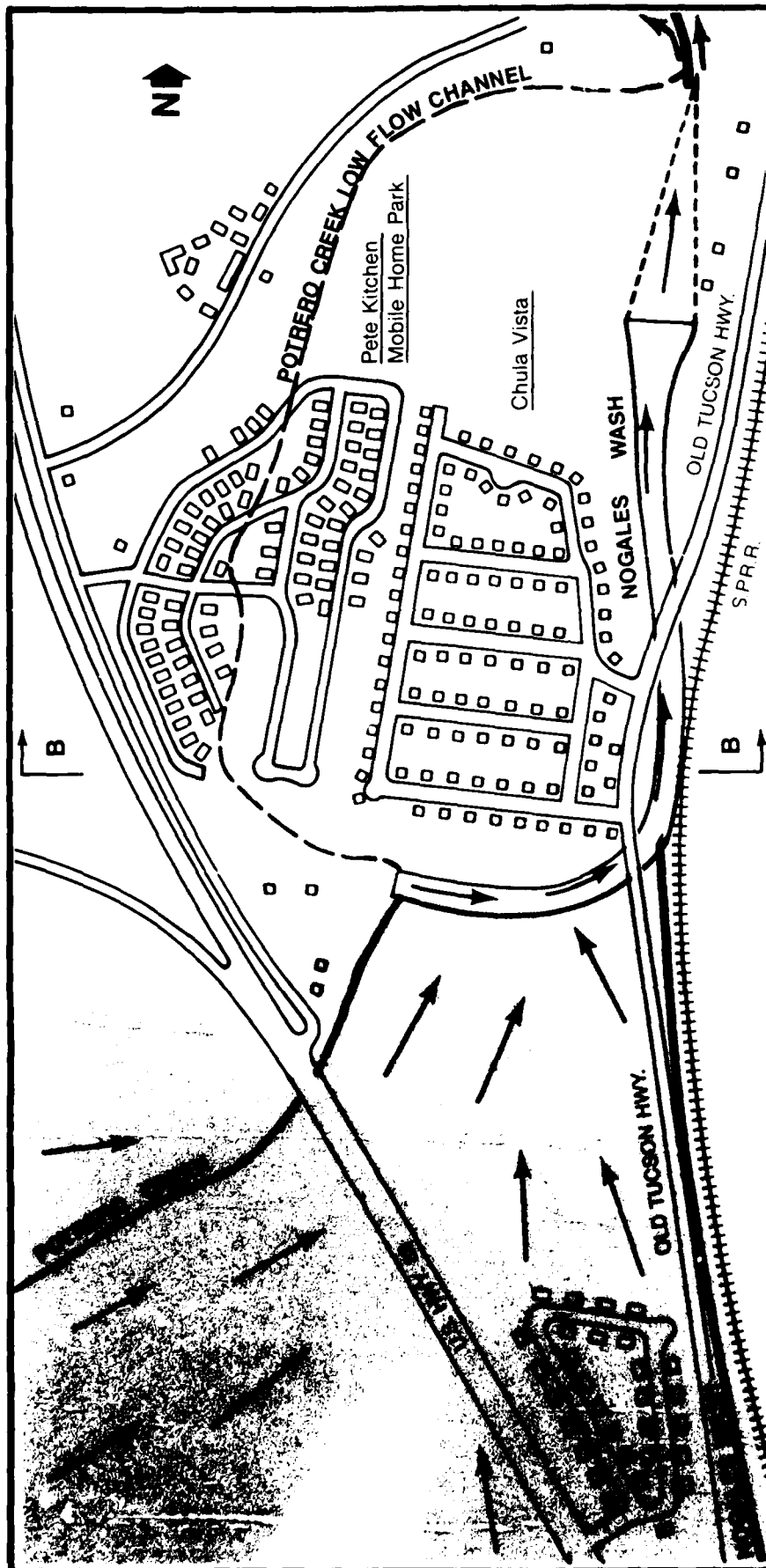
SOUTHERN PACIFIC
RAILROAD

Figure 16

CHULA VISTA CHANNELS
Without Project Plan

NOTE: THIS DRAWING IS NOT TO SCALE





LEGEND

- WITH PROJECT OVERFLOW
- EXISTING WATER COURSES
- FLOW INDICATOR
- S.P.R.R. SOUTHERN PACIFIC RAILROAD
- CHULA VISTA CHANNEL
- CHANNEL SHAPING
- SECTION (B-B) SEE FIGURE 19

NOTE: THIS DRAWING IS NOT TO SCALE

Figure 18
CHULA VISTA CHANNELS
With Project Plan

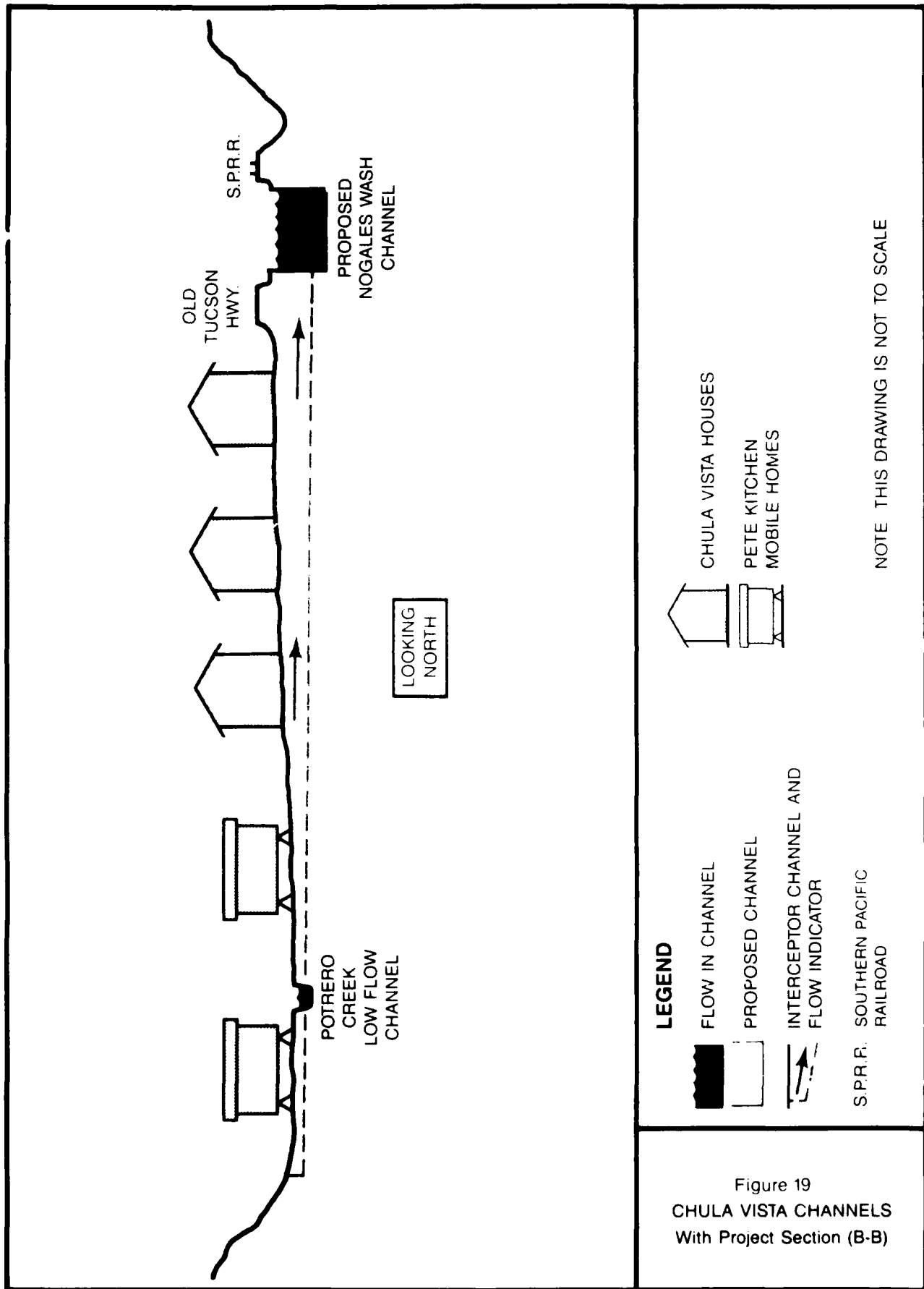


TABLE 19. Sensitivity of Future Inlet Conditions
(October 1986 Price Levels @ 8 7/8%)

SCENARIO 1: FUTURE CONDITION OF INLETS IS SAME AS PRESENT

Design Level of Protection (YRS)		Constr. First Cost (\$X1000)	Annual Cost (\$X1000)	Attributable Annual Benefits (\$X1000)	Attributable Benefit Cost Ratio	Attributable Net Benefits (\$X1000)	Attributable Level of Protection (YRS)		Actual Level of Protection (YRS)	
Present	Future						Present	Future	Present	Future
27	20	445	41	554	13.58	513	27	20	27	20
40	28 1/2	729	67	610	9.14	543	40	28 1/2	40	28 1/2
44	33	936	86	637	7.44	552	44	33	44	33
66	50	5,760	533	1,019	1.91	486	66	50	66	50
130	100	8,000	740	1,109	1.50	369	130	100	130	100
250	200	11,000	1,018	1,161	1.14	143	250	200	250	200

SCENARIO 2: ALL 4 INLETS TOTALLY PLUGGED IN FUTURE

Design Level of Protection (YRS)		Constr. First Cost (\$X1000)	Annual Cost (\$X1000)	Attributable Annual Benefits (\$X1000)	Attributable Benefit Cost Ratio	Attributable Net Benefits (\$X1000)	Attributable Level of Protection (YRS)		Actual Level of Protection (YRS)	
Present	Future						Present	Future	Present	Future
27	20	445	41	230	5.02	199	1	1	1	1
40	28 1/2	729	67	315	4.70	248	2	2	2	2
44	33	936	86	345	4.01	259	4	4	4	4
66	50	5,760	533	480	2.17	437	17	17	17	17
130	100	8,000	740	525	1.90	45	45	45	45	45
250	200	11,000	1,018	550	1.98	30	50	50	100	200

SCENARIO 3: ALL 4 INLETS TOTALLY OPEN AND CLEAR IN FUTURE

Design Level of Protection (YRS)		Constr. First Cost (\$X1000)	Annual Cost (\$X1000)	Attributable Annual Benefits (\$X1000)	Attributable Benefit Cost Ratio	Attributable Net Benefits (\$X1000)	Attributable Level of Protection (YRS)		Actual Level of Protection (YRS)	
Present	Future						Present	Future	Present	Future
27	20	445	41	540	12.17	499	27	20	42	24
40	28 1/2	729	67	591	8.82	524	40	28	34	29
44	33	936	86	614	7.26	528	44	33	44	33
66	50	5,760	533	993	1.94	460	66	47	66	50
130	100	8,000	740	1,076	1.45	336	130	80	130	100
250	200	11,000	1,018	1,123	1.12	105	250	120	250	200

SCENARIO 4: EXISTING BOXES TOTALLY FILLED IN FUTURE

Design Level of Protection (YRS)		Constr. First Cost (\$X1000)	Annual Cost (\$X1000)	Attributable Annual Benefits (\$X1000)	Attributable Benefit Cost Ratio	Attributable Net Benefits (\$X1000)	Attributable Level of Protection (YRS)		Actual Level of Protection (YRS)	
Present	Future						Present	Future	Present	Future
27	20	445	41	0	N.A.	-41	0	0	44	33
40	28 1/2	729	67	0	N.A.	-67	0	0	44	33
44	33	936	86	0	N.A.	-86	0	0	44	33
66	50	5,760	533	0	N.A.	-533	0	0	66	50
130	100	8,000	740	0	N.A.	-740	0	0	130	100
250	200	11,000	1,018	0	N.A.	-1,018	0	0	250	200

Note: The above analysis was performed in August 1987. Costs and Benefits have since changed, however, they would not significantly affect the results of this analysis.

Table 20. Summary of Reach 4 Channel Reevaluation
(October 1966 Price Levels F B 1/85)

Sub- Reach	Average Annual Benefit Per Level Project of Protection (\$1000)			C.P.	Frequency Discharge Values (cfs)			Channel Length (Miles)	Reconnaissance Phase Est. Const. Cost per In Mile of Channel (\$1000)			Reconnaissance Phase Estimated Const. Cost Per Subreach (\$1000)			Feasibility Phase Adjusted Present Value to Allow For IDC (\$1000)			Benefit-Cost Ratio			
	20 YR	50 YR	100 YR		20 YR	50 YR	100 YR		20 YR	50 YR	100 YR	20 YR	50 YR	100 YR	20 YR	50 YR	100 YR	20 YR	50 YR	100 YR	
	(\$1000)	(\$1000)	(\$1000)		(\$1000)	(\$1000)	(\$1000)		(\$1000)	(\$1000)	(\$1000)	(\$1000)	(\$1000)	(\$1000)	(\$1000)	(\$1000)	(\$1000)	(\$1000)	(\$1000)	(\$1000)	
1	133	97	122	1.29	7	87,800	12,000	18,000	1.47	2650	3030	3550	3866	4454	5119	989	1244	1316	0.75	0.28	0.25
2	4	2	3	4	7	7,800	12,000	18,000	0.21	2650	3030	3550	610	697	817	20	31	41	0.03	0.04	0.05
3	200	124	175	191	8	8,500	13,500	20,500	1.07	2700	3150	3838	2869	3771	4098	1265	1785	1948	0.44	0.51	0.48
4	20	12	17	149	8	8,500	13,500	20,500	0.60	2700	3150	3838	1670	1890	2298	122	173	194	0.08	0.09	0.08
5	350	207	332	416	9/10	5,400	9,100	14,000	0.23	2420	2760	3700	557	635	736	2932	3391	3595	1.08	1.02	0.92
					11	10,000	16,000	21,500	0.27	5700	6240	8240	1539	1920	2225						
					11	10,000	16,000	21,500	0.27	Energy Dissipator			221	490	550						
					11	10,000	16,000	21,500	0.27	2 bridges			400	770	800						
					11								S.T.	2717	3911						
6	42	154	169	175	11	10,000	16,000	21,500	1.22	2850	3370	4130	3617	4111	5039	1570	1723	1784	0.45	0.42	0.35
7	6	2	4	5	12	10,500	17,500	24,500	0.85	2895	3530	4270	2661	3001	3587	1249	1269	1279	0.51	0.46	0.36
785	799	943	996						5.94	2974	3512	4204	17610	20659	24969	8148	9616	10157	0.46	0.46	0.41

Creek. Future involvement of SCS may be provided upon specific requests made by the local communities.

b. Fourth iteration

Figure 20 illustrates the measures investigated in the fourth iteration. Prior to initiating the fourth iteration, Corps representatives again met with the local sponsor. The results of the third iteration were discussed and a consensus was reached as to what measures would be taken to the final or fourth iteration of feasibility phase design. Based primarily upon economic justification and specific goals (to be discussed further in Section F.2 of the chapter) of the local sponsor, the following measures were identified as those to be taken into the fourth iteration:

- * 33-year (future condition) lateral collector channel system
- * 100-year (future condition) Chula Vista channel system
- * 20-year (future condition) Chula Vista channel system
- * flood warning system
- * recreation plan

NOTE: A recreation needs assessment performed in the third iteration illustrated that there was a need for recreation facilities in the study area. A specific plan could not be developed, however until the fourth iteration when lands (available for recreation) were identified, and the potential recreation impacts upon the riparian habitat could be determined.

In the fourth iteration, the final array of alternatives were taken to the final feasibility phase level of technical analysis. This included hydraulic design, engineering design and cost estimates, recreation and aesthetic treatment, design and cost estimates, environmental analysis/mitigation requirements and cost estimates, real estate requirements and cost estimates, and the final evaluation of potential project economic relationships. Figure 20 identifies the measures evaluated in this iteration; Table 21 is a summary of the resulting economic analysis.

(1) LATERAL COLLECTOR CHANNEL

No significant changes were made in the design concept of the lateral collector channel (LCC) system. Engineering plans, profiles, and cross sections were developed (Plates 5 and 6). Due to the fact that the LCC system is entrenched and is located in an area of dense urban development, it was determined that the environmental impacts resulting from this solution would be minimal (see attached environmental assessment). This measure would not provide an opportunity for recreational development as it would be located in a congested border crossing setting where it is important to move people and vehicles through as quickly as possible. The visual or aesthetic impacts of the LCC would be minimal. However, a project safety fence along the open portion of the LCC (east of the railroad) would be required. Color coating this chain link safety fence and incorporating a matching scheme of bright colors and supergraphics on the grated inlet in the west side channel, would mitigate the LCCs visual character.

It was determined that there would not be real estate costs associated with the LCC system since this feature would be constructed within a 60-foot IBWC

right-of-way (this right-of-way extends 60 feet both north and south of the International Boundary) and portions of existing City of Nogales street rights-of-way. No privately owned lands would be required.

Final hydraulic analysis of present and future, with and without project overflows (Plate 4) provided the economic analysis as outlined in Table 21. These results affirm the position that the 33-year future condition (44-year present condition) LCC system would provide the NED level of protection.

At several times throughout this study, concerns were raised about the possibility of odor escaping from the covered channels via the LCC system. These concerns were accounted for in the final design phase. Both the open and grated collector channels were designed with an invert higher than the normal water surface in the existing covered channels. This would prevent dry weather low flows in the covered channels from entering the LCC system. Any water entering the LCCs, however, would drain into the covered channels. Also designed into the system are flap gates on all pipes connecting the collector channels to the covered channels. This feature would prevent even high flows in the covered channels from backing up into the LCC system, and would also significantly reduce the possibility of the LCC system transmitting odor from the existing covered channels.

It was determined that the existing covered channel system, which originally had a project life of 100 years, has a remaining project life of approximately 50 years. This is a result of scour from the constant flow of water in the channel invert over the past 50 years. As such, in order to be consistent with the proposed project life of the LCC system (100 years), repairs to the channel invert would have to be made from the border to the covered channel outlets. It was also found that in terms of economic justification (NED), the repair of the invert should be accomplished in 50 years rather than at present. The present value of this future repair was determined, and included in the first cost of the LCC (see Table 25F; line titled "Future Repairs/Replacement").

(2) 100-YEAR CHULA VISTA CHANNELS

Several significant engineering changes were made to the Chula Vista Channels (CVC) in the fourth iteration. Plates 7 and 8 illustrate this measure. Detailed hydraulic design found that because of high velocities and scour, the Chula Vista/Potrero interceptor channel (CVPIC) would require a grouted stone bottom rather than earth as had been considered in the third iteration. It was also determined that the berm on the north side of the interceptor channel (used to contain a portion of the flow) would have to be somewhat higher than originally considered. The maximum height of this berm above the existing grade came to be about 12.1 feet. This berm would provide 100-year (future condition) protection and included 3 feet of freeboard, however, there would still be a chance of overtopping during the life of the project. To prevent the potential of catastrophic failure, the design incorporated grouted stone armoring on all faces to include a 10 foot deep toe on the downstream side.

The alignment of the Chula Vista/Nogales Wash channel (CVNWC) was straightened somewhat more and the slope of the invert was increased to obtain greater channel capacity in the area restricted by the Old Tucson Highway and

the Southern Pacific railway. As a result, the size of the energy dissipator/outlet channel was increased to compensate for this effect.

In the fourth iteration, an analysis was made of the existing riparian habitat that would be lost as a result of implementing this CVC measure, and a determination was made as to how this loss would be mitigated. This analysis is described in detail in Section 4.3 and Appendix C of the attached Environmental Assessment (EA). The determination of mitigation requirements was made using a Habitat Evaluation Procedure (HEP). This procedure identified the probable loss of riparian habitat in terms of average annual habitat units, as a result of the proposed project. To ensure no net loss of habitat, the same number of habitat units would be incorporated into the proposed plan. It was found that only a portion of the loss could be mitigated on project lands. This, however, could be accomplished by utilizing riparian species of trees within the project rights-of-way for aesthetic treatment purpose. This action would not incur additional mitigation costs. It was found, however, that additional mitigation would be required and additional lands for this purpose would have to be identified. First, public lands were sought to accomplish this, however, it was determined that none were available, as river bottom lands in this area are typically owned by private individuals/firms. As a last resort, private lands were sought that already had an existing, well established stand of riparian habitat. Lands along potrero creek, between the proposed Chula Vista interceptor channel and the confluence with Nogales Wash, were identified as a likely source as they 1) already had an established stand of riparian habitat and would not require extensive planting, 2) Potrero Creek would continue to provide the required water supply for this habitat, and 3) these lands could not be readily developed, even with the proposed project, and would be relatively easy to acquire. Figure 22 illustrates the areas where aesthetic treatment (creditable to mitigation) would take place within the project rights-of-way and the areas where additional lands would be obtained to complete the mitigation requirement. It was also determined that a small amount of recreation activity within or adjacent to the mitigation areas would not interfere with the mitigation plan. Therefore, a recreation plan was developed, that would be compatible with the restrictive project lands. This plan will be discussed later in this section.

Real estate requirements and costs were determined for the 100-year CVC. It was determined that the land requirements for the CVPIC and the CVNWC would be acquired in fee title or perpetual easement. Additional lands needed for mitigation would be acquired in perpetual easements. Real estate costs included severance damage for several houses near the project boundaries.

The final economic analysis of the 100-year (future condition) CVC is illustrated in Table 21. In comparison with the third iteration no significant changes were found in either project benefits or project costs, however, as will be discussed later in this section, the fourth iteration results illustrated that the 100-year CVC measure would provide greater net benefits than the 20-year CVC and as such would become the NED level of protection.

(3) 20-YEAR CHULA VISTA CHANNELS

The 20-year (future condition) CVC is mostly a scaled down version of the 100-year CVC. It has the same project features, but channel widths and depths

LEGEND

- |— NOGALES WASH STUDY AREA
- - - INTERNATIONAL BOUNDARY
- ...→ TRIBUTARIES SIGNIFICANT TO PROPOSED MEASURES

MEASURES EVALUATED

- ▤ LATERAL COLLECTOR CHANNELS
- ||||| INCREASED CHANNEL CAPACITY RESULTING FROM LATERAL COLLECTOR CHANNEL

- OPEN CHANNEL
- SELF REPORTING RAIN GAGE
- ▲ SELF REPORTING STREAM GAGE
- △ SELF REPORTING STREAM GAGE WITH SIREN

STRUCTURAL MEASURES

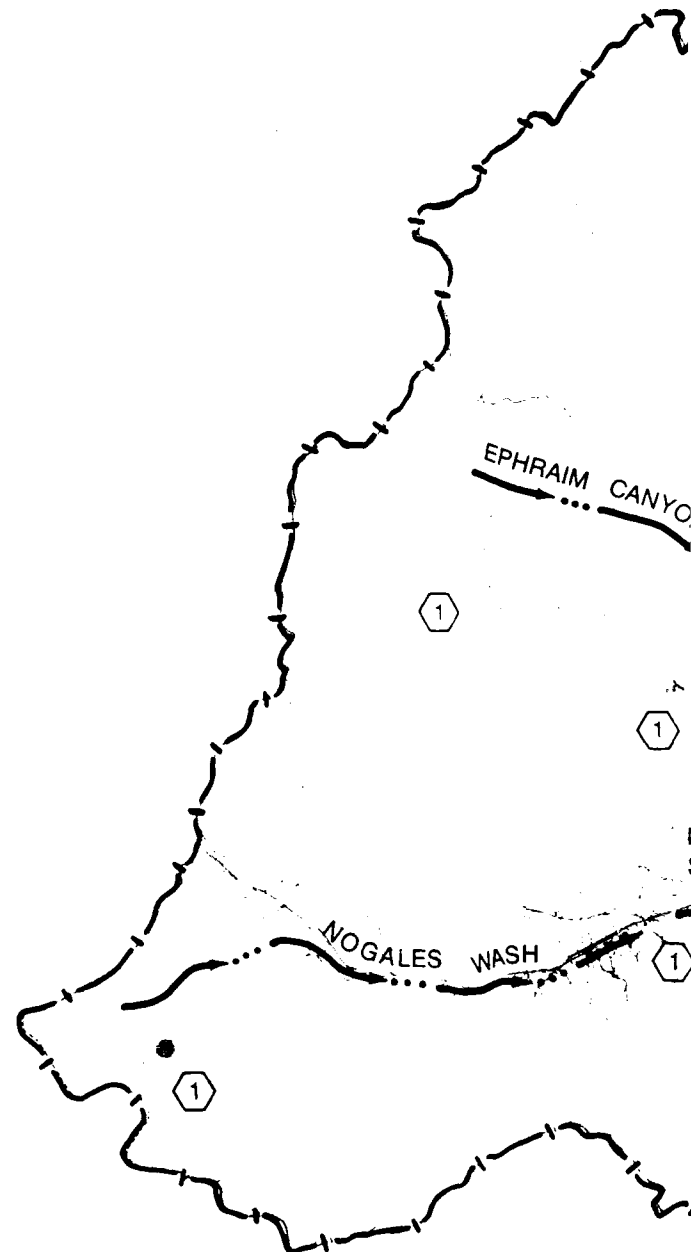
- 1. LATERAL COLLECTOR CHANNELS
- 2. CHULA VISTA CHANNELS

NONSTRUCTURAL MEASURES

- 1. FLOOD WARNING SYSTEM COMPONENT
- 2. SANTA CRUZ COUNTY SHERIFF/ DEPARTMENT OF PUBLIC SAFELY

RECREATION

- 1. CHULA VISTA RECREATION DEVELOPMENT



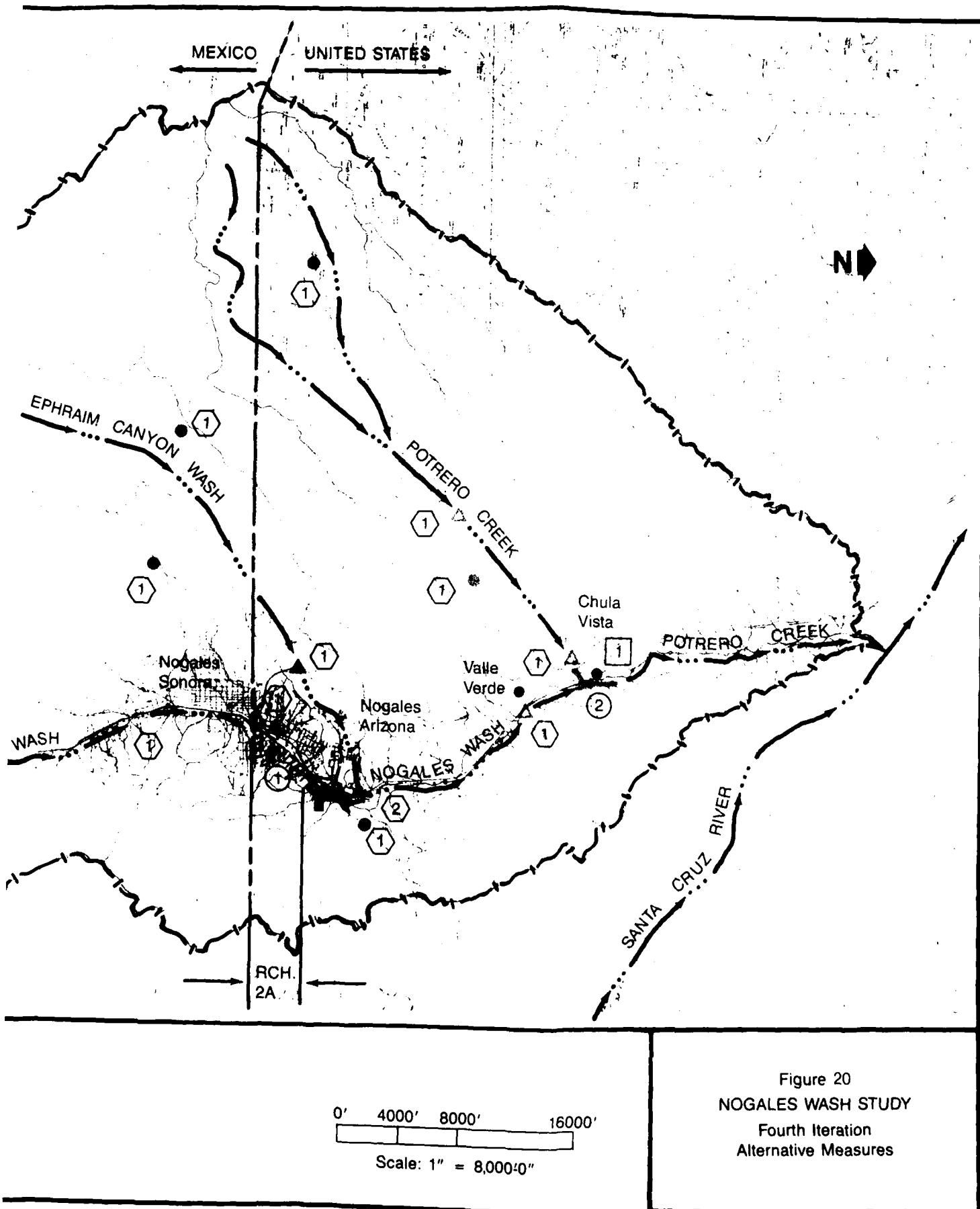


Figure 21. Flood Warning System

See Figure 20, "Non-Structural Measures"

Table 21. Summary of Fourth Iteration Alternative Measures
(October 1986 Price Levels @ 8.7/8%)

		First Cost (\$1000)	Annual Cost (\$1000)	Annual Benefits (\$1000)	Benefit Cost Ratio	Net Benefits	Findings/Recommendations
Reach 2A							
*International Boundary	33-year Lateral Collector Channel	738.7	68	618	9.1	550	Confirmed as NED, Contained in Recommended Plan
Reach 4							
*Chula Vista	Construct 20-year Chula Vista Channel	3610	338	412	1.2	74	Not NED
*Chula Vista	Construct 100-year Chula Vista Channel	5140	478	563	1.2	85	Confirmed as NED, Contained in Recommended Plan
*Chula Vista	Recreation Plan	23	4	9	2.5	5	Contained in Recommended Plan
*All Reaches	Flood Warning System	119	11.8	24.8	2.1	13	Contained in Recommended Plan

are typically somewhat smaller. Environmental, recreation, aesthetic treatment, real estate and economic analysis were conducted at the same level of detail as for the 100-year CVC. The economic results of this measure are illustrated in Table 21. It should be noted that the results of the third iteration indicated that the 20-year CVC would be the NED level of protection, however, estimated construction costs for this measure increased over those estimated earlier and the net benefits decreased. As a result, the 100-year design was identified as the NED level of protection.

(4) FLOOD WARNING SYSTEM

In the fourth iteration, the flood warning system (FWS) was analyzed in detail (Figure 21). This system would cover approximately 76 square miles of drainage area. The hardware of this system alone would provide approximately one hour warning of an impending flood to much of the flood prone areas in the Nogales Wash drainage basin. This system, however, coupled to other flood warning systems and data bases of the National Weather Service (NWS) would have an extended advanced warning time of approximately six (6) hours. Not only would there be a significant reduction to the threat of human life, but enough time would be provided so that flood fighting techniques could be utilized to reduce significant flood damage.

The FWS would utilize:

- 7 - self reporting rain gages (SRRG)
- 3 - self reporting stream gages
- 3 - self reporting stream gages with sirens
- 1 - fully equipped repeater including receiving antenna
- 1 - microcomputer

Four of the self reporting rain gages and one self reporting stream gage are located in Mexico. At the time of this report, it is felt that these devices are imperative for advanced flood warning in the downtown Nogales, Arizona community. It is understood that continued coordination would be required through the IBWC to enable these gages to be installed and maintained in Mexico. The gages in Mexico could also be interfaced with, and provide flood warning to the Sonoran community, which in itself, may provide an incentive to this plan. Flood warning for the downstream portion of the study area can be provided with devices entirely within the United States.

In the analysis, it was found that the FWS would be economically justified. The relatively short advanced warning time of 1 hour provided by the hardware itself, would be increased to approximately 6 hours with the use of input from the NWS. This extended warning would provide enough time to flood fight and reduce flood damage. The hardware of the FWS has a life expectancy of approximately 20 years. This means that over a 100-year project life, the components would typically have to be replaced four times. The replacement costs would therefore have to be taken into account when evaluating the cost effectiveness of this system. Table 21 shows the results of the economic analysis for the FWS.

(5) RECREATION PLAN

As was indicated earlier in this section, the lateral collector channel (LCC) would not provide an opportunity for recreation development. Likewise,

the flood warning system (FWS) would not either. It was determined that lands available for recreation would be limited to within the channel right-of-way or within the mitigation easements of the 20-year and 100-year Chula Vista channel (CVC) system. Again it is pointed out that the mitigation lands would be acquired in fee title or perpetual easements. Further consideration indicated that high recreational use in these areas may significantly impact the mitigation requirement to protect the riparian habitat within project lands. As a result, a recreation plan was developed that would have minimal impacts upon the riparian habitat (Figure 22).

Figure 22 illustrates the proposed Chula Vista recreation plan (CVRP) in relationship to the 100-year CVC measure. No significant changes would result from implementation of the 20-year CVC measure.

The recreation plan would provide three separate picnic sites and would make use of the proposed 15 foot wide, 1580 foot long paved access road as a bicycling/hiking trail. Each picnic site would include a concrete slab, a picnic table, a grill, and a shelter structure. The economic evaluation of this plan is illustrated in Table 21. This recreation plan reduces the excess recreation demand in the recreation market area (Nogales vicinity) by less than 1% (from 563,191 to 559,992 annual recreation days).

c. Summary of feasibility phase

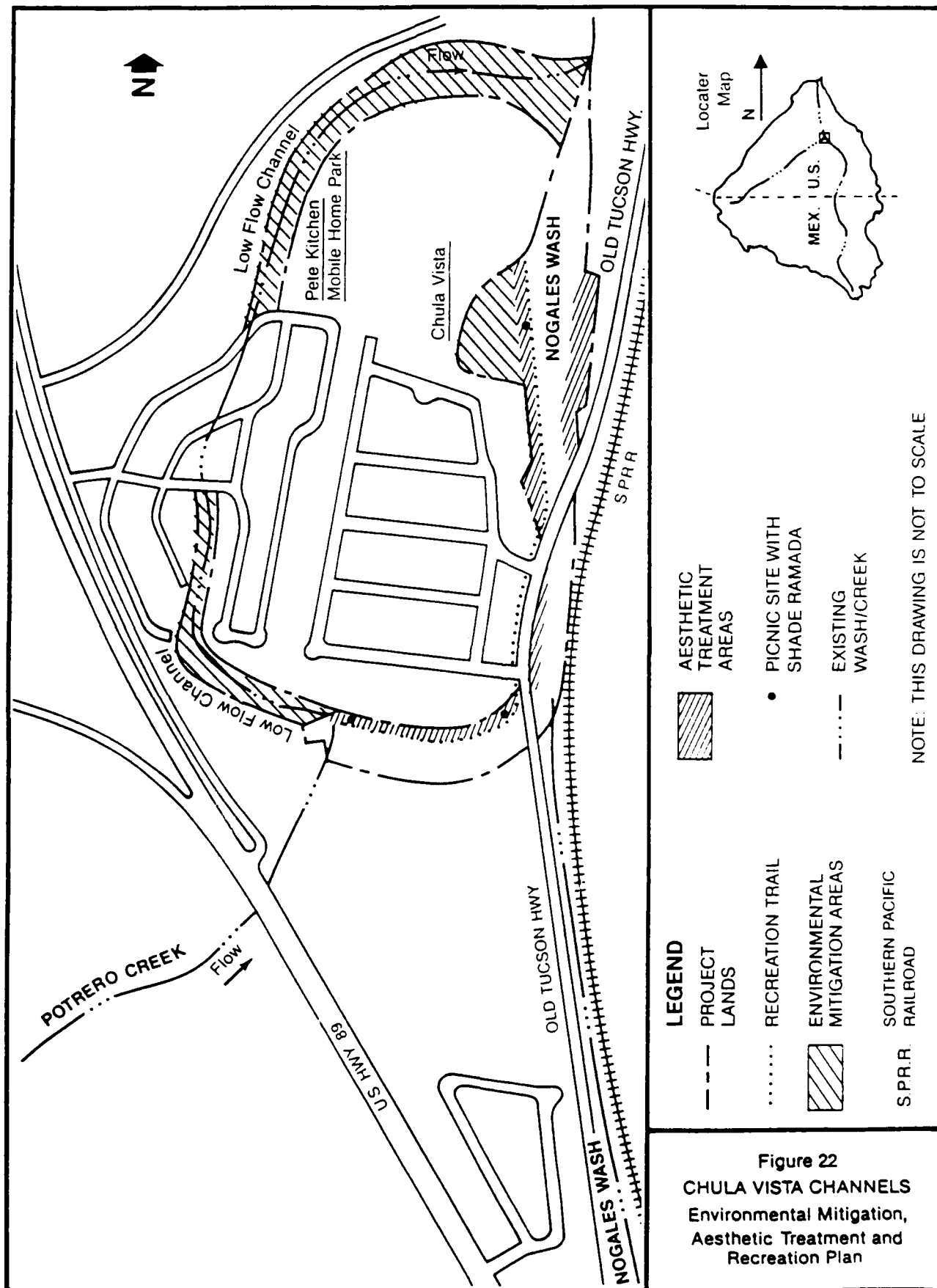
As a result of the fourth iteration, it was reconfirmed that the 33-year (future condition) lateral collector channel (LCC) system was justified and would provide the NED level of protection. It had previously been determined that the 20, 23 1/2, 50, 100, and 200-year level of protection plans were also justified, but would not provide the NED plan.

Both the 20-year and the 100-year CVC were analyzed in the final or fourth iteration. The 20-year CVC was taken into the fourth iteration since its net benefits at the end of the third iteration were slightly larger than those of the 100-year CVC. The 100-year CVC was also taken to the fourth iteration since its net benefits were almost as much as the 20-year CVC and since the local sponsor strongly preferred this measure. The results of more detailed design and development analysis in the fourth iteration indicated that the 100-year CVC would provide the NED level of protection.

A passive recreation plan was developed that would provide three picnic sites and a bicycling/hiking system for the 100-year CVC measure. This plan was designed so that the recreation activities would not impair the protection response to the riparian habitat.

Analysis of the flood warning system indicated that it would be economically justified and should be included in the Recommended Plan. This system would significantly reduce the possibility of loss of life and reduce flood damage.

The analysis of alternative measures in the feasibility phase also determined that a comprehensive channel in Reach 4 would not be economically justified. Subsequent analysis also proved negative for floodwalls in the Valle Verde community.



SEP 7 1988

Although it was determined that bank erosion in Reach 4A is a significant problem, it was found that justification of formal bank protection measures is unlikely do to the fact that most of the erodible lands are presently undeveloped and lie within the FEMA floodway. Also, several lines of Kellner jacks had also been placed in the reach near Firestone Gardens and appear to be working effectively. For these reasons it was determined that the Corps, in this study, would not continue analysis of bank protection measures.

d. Development of Alternative Plans

At the end of the feasibility phase, many alternative measures had been developed to assist in addressing the objectives of this study (these objectives were illustrated in section A of this chapter). Measures once again, are specific solutions for specific problems at specific locations.

Alternative plans were then developed that would combine various measures and provide more comprehensive solutions. Each plan developed represents a potential Corps action that could be taken to address the study objectives. The intent then is to select only one plan for implementation. This section will identify the plans that were developed (section F.1) and will illustrate the basis for their development (section F.2).

3. Plan Identification

The following is an identification of the plans developed for this report. Identified below each plan are the measures which are included in that specific plan. Most of the measures identified would provide a specific level of protection. The level of protection will be identified by two numbers separated by a (/). The first number represents the "future" level of protection provided by the measure. The second number represents the "present" level of protection that would be provide. The reason for this difference again is based upon the projected future land development and increase in future storm runoff.

a. Alternative 1

- * 33/44-year lateral collector channel
- * 100/125-year Chula Vista channels
- * Recreational plan
- * Flood warning system

b. Alternative 2

- * 33/44-year lateral collector channel
- * 20/24-year Chula Vista channels
- * Recreation plan
- * Flood warning system

c. Alternative 3A

- * 100/133-year lateral collector channel with additional covered channel in Reach 2A
- * 100/125-year Valle Verde channel
- * 100/125-year Chula Vista channel
- * Flood warning system

d. Alternative 3B

- * 100/133-year lateral collector channel with additional covered channel in Reach 2A
- * 100/125*-year channel modifications to Reach 3
- * 100/125-year Valle Verde channel
- * 100/125-year Chula Vista channels
- * 100/125*-year channel in Reach 4A
- * Flood warning system

e. Alternative 4

- * no action

4. Basis Of Plan Development

As part of the Corps intensive public involvement program, Corps representatives met with the local sponsor at the end of the third iteration to determine what alternative measures would be detailed in the fourth and final iteration. Current Corps policy to include Federal interest, NED level of protection and the conditions required to select a plan other than the NED level of protection were addressed. The goal of the local sponsor was clearly to provide 100-year protection to the entire community from the International Boundary to the confluence of the Santa Cruz River. It had been determined by then that a portion of the sponsors plan would not be economically justified and as such this plan could not be the "selected plan". The sponsor indicated that it would fully support the Corps' selected plan, but requested that a local plan (LP) be developed and analyzed. Those portions of the LP that were found to be unjustified in earlier iterations were updated in terms of costs and benefits. No further technical analysis was be done on them.

The following paragraphs provide the basis for the development of each of the plans.

a. Alternative 1

Alternative 1 is the NED flood control plan (100/125-year CVC and 354-year LCC) to include the recreation plan and flood warning system (FWS). Figure 23 illustrates this plan.

Because of the very limited potential for recreation development within project limits, one recreation plan was developed. It was determined that any additional development may have serious impacts upon the riparian habitat, which would require mitigation for any loss thereof. The recreation plan would, however, provide a net benefit to the community and would be in the Federal interest.

It was determined that Alternative 1 would be in the Federal interest and would also be fully supported by the Santa Cruz County.

b. Alternative 2

Alternative 2 is the same as alternative 1 with the exception of a 254-year CVC instead of the 100/125-year CVC. Figure 24 illustrates this plan. This alternative was developed on the third iteration assumption that this lower level of protection measure may be the NED Plan. Although this was not the

case, it was identified as a plan for comparative purposes. This plan is not the NED plan and is not supported by the local sponsor, because of the low level of protection at Chula Vista.

c. Alternative 3A

Alternative 3A is one of two variations of an alternative plan that represent the local sponsor's goals toward flood control. The goal of this variation is to provide 100-year protection along the mainstem from the International Boundary through the Chula Vista community. Figure 25 illustrates this plan. The exception to this goal is that no improvements would be made to the open concrete channel section in Reach 3. This reach presently has a design capacity ranging from approximately 8700 cfs to 12,000 cfs (30-year to 60-year present condition level of protection) and would not be modified in this alternative plan. This plan would include an enlarged LCC system that would capture the 100-year overland flows at the International Boundary and additional covered channel in reach 2A to create a total channel capacity there, of 100-year. Although some flood flows would break out of the open concrete channel in reach 3, damages there are relatively small.

Caution should again be noted that the 100/133-year lateral collector channel system and the 100/125-year Valla Verde channel were not taken to the final feasibility phase level of design, because it had been determined that they were not economically justified. The local sponsor, however, would support this alternative.

d. Alternative 3B

This alternative is the second variation of the locals plan. Alternative 3B would provide 100-year protection on the Nogales Wash/Potrero Creek mainstem from the International Boundary to the end of reach 4A. Figure 26 illustrates this plan which would include all of the measures of alternative 3A with the addition of channel modifications that would increase the level of protection in Reach 3 to 100-year, and 100-year channelization in Reach 4A. The local sponsor requested that this plan be developed since it fully illustrated their goals in regard to flood control, in the Nogales, Arizona vicinity.

Again, caution is noted that the additions to this plan, the 100/125-year modification to Reach 3, and the 100/125-year channel in Reach 4A, were not taken to the final feasibility phase level as it had been determined that they were not economically justified.

e. Alternative 4

A "no action" alternative was developed and will be compared to the other plans in the following section. This plan is always considered where Federal action is being considered.

F. COMPARISON OF ALTERNATIVE PLANS

The alternative plans were formulated in such a way that they exhibit the potential for being (1) complete (contain the necessary ingredients to realize desired benefits), (2) effective (alleviate the problems and realize the opportunities), (3) efficient (the most cost effective), and (4) acceptable

(feasible from an economic, social, environmental, political and financial standpoint). This provided an effective way to identify plans that were to be considered further. Table 22 illustrates the comparison of the alternative plans based upon the above criteria.

G. PLAN SELECTION

The goal again is to tentatively select one plan for implementation. The following analysis was used to make this selection:

1. Alternative 1

Alternative 1 is the NED plan and meets all criteria as outlined above. It is the only plan that does, and as such, is the Recommended Plan. This plan is discussed in detail in the following chapter.

2. Alternative 2

Alternative 2 was dropped from further consideration since it is not the NED plan. It was determined that it would not be as effective as alternative 1 since it provided a lower level of protection, and was not acceptable to the local sponsor and residents of the Chula Vista community for the same reasons.

3. Alternative 3A

Alternative 3A was dropped from further consideration as it was not the NED and because major portions of the plan would not be economically justified. This plan would require additional feasibility phase analysis before it could be considered for Federal implementation. This plan was developed at the request of the local sponsor.

4. Alternative 3B

Alternative 3B was dropped from further consideration for the same reasons as for alternative 3A.

5. Alternative 4

The "no action" alternative will be carried forward and used for comparative purposes with alternative 1 (the recommended plan).

6. Summary

As illustrated above, alternative 1 was identified as the "recommended plan". It will be carried forward along with the "no action" alternative (Alternative #4).

TABLE 22. Comparison of Alternative Plans

	<p><u>ALTERNATIVE 1</u> *10/44 Year FV *100/125 Year CVC *Flood Warning System *Recreation Plan</p>	<p><u>ALTERNATIVE 2</u> *10/44 Year FV *100/125 Year CVC *Flood Warning System</p>
<u>COMPLETENESS:</u>	Complete protection in downtown beach 2A (10/44 yr.) and at Chula Vista (100/125 yr.) only. Would provide flood warning to approximately 80% of drainage area and provide some needed passive recreation.	Complete protection in downtown beach 2A (10/44 yr.) and at Chula Vista (100/125 yr.) only. Would provide flood warning to approximately 80% of drainage area and provide some needed passive recreation.
<u>EFFECTIVENESS:</u>	Effective in reducing frequent flood damages in downtown Nogales and in Chula Vista community. Interior drainage in downtown area would result in minor residual damages with less than 100-year floods. Flood warning system would reduce potential for loss of life and would provide some economic benefits. Recreation plan would provide some needed passive recreation. This alternative is the most effective plan in terms of realizing economic opportunities.	More effective than Alternative 1 except that the drainage area would be less. Flood warning system would reduce potential for loss of life and would provide some economic benefits. Recreation plan would provide some needed passive recreation. This alternative is the most effective plan in terms of realizing economic opportunities.
<u>EFFICIENCY:</u>	Efficient - Maximizes MFR benefits.	Efficient - Maximizes MFR benefits.
<u>ACCEPTABILITY:</u>	Acceptable - would provide MFR benefits.	Acceptable - would provide MFR benefits.
<u>Economic:</u>	Acceptable - would provide MFR benefits.	Acceptable - would provide MFR benefits.
<u>Social:</u>	Flood control portion are acceptable in downtown and Chula Vista community. Flood warning system and recreation plan are acceptable to entire community. Minimal disruption during construction phase.	Flood control portion are acceptable in downtown and Chula Vista community. Flood warning system and recreation plan are acceptable to entire community. Minimal disruption during construction phase.
<u>Environmental:</u>	Acceptable with purposeful mitigation requirement for no net loss of riparian habitat. The potential for disturbing undisturbed prehistoric site exists.	Acceptable with purposeful mitigation requirement for no net loss of riparian habitat. The potential for disturbing undisturbed prehistoric site exists.
<u>Political:</u>	Acceptable - local sponsor and other government agencies fully support this alternative. Attitudes of DPC on Inter-national institutions would be minimal.	Not acceptable - local sponsor and other government agencies fully support this alternative. Attitudes of DPC on International institutions would be minimal.
<u>Financial:</u>	Acceptable - local sponsor and federal government under the administrators current construction cost appropriation guidelines.	Acceptable - local sponsor and federal government under the administrators current construction cost appropriation guidelines.
<u>Legal:</u>	Acceptable - No legal problems.	Acceptable - No legal problems.









TABLE 22. Comparison of Alternative Plans (Continued)

	<p><u>ALTERNATIVE 3A</u> *100/133 Year LCC *100/125 Year VVC *100/125 Year CVC *Flood Warning System *Recreation</p>	<p><u>ALTERNATIVE 3B</u> *100/133 Year LCC *100/125 Year Reach 3 Chan *100/125 Year VVC *100/125 Year CVC *100/125 Year Reach 4A Chan *Flood Warning System *Recreation</p>	<p><u>ALTERNATIVE 3C</u> *No Action</p>
<u>TECHNICAL FEASIBILITY:</u>	Same measures as alternative 1 with an increased level of protection in downtown Reach 2A (100/133 yr.) and additional protection (100/125 yr.) in Valle Verde.	Same measures as alternative 3A with additional protection (100/125 yr) in Reach 3, and Reach 4A (100/125 yr). This alternative is the most comprehensive plan in terms of improvements.	Incomplete - no means to realize desired benefits.
<u>ECONOMIC FEASIBILITY:</u>	Increased effectiveness in level of protection and in reducing interior flood damage in the downtown area. Also would provide additional protection (100/125 yr) to Valle Verde community.	Most effective plan in terms of level of protection (100 yr at all locations) and in terms of area protected (from International Boundary thru Reaches 2A, 3, 4B, and 4A). This alternative is the most effective plan in terms of alleviating problems.	Ineffective - No flood damages reduced. No sponsor would contribute, seek other means to address flooding.
<u>ENVIRONMENTAL FEASIBILITY:</u>	Some minor improvements in downtown area, but could not be economically justified. This plan would not provide any net economic benefits.	Most effective improvements in downtown area, Reach 3, and Reach 4A except Chula Vista. Could not be economically justified. This plan would not provide any net economic benefits.	Effective - No flood damages reduced. No sponsor would contribute, seek other means to address flooding.
<u>FINANCIAL FEASIBILITY:</u>	Unacceptable - Portions of plan would not be economically justified.	Unacceptable - Portions of plan would not be economically justified.	Acceptable - No net economic benefits.
<u>SOCIAL FEASIBILITY:</u>	More acceptable to entire community as a larger area received benefits. This plan would incur a larger social disruption during the construction phase.	Most acceptable to entire community - largest area received benefits. This plan would incur the largest social disruption during the construction phase.	Not acceptable - No net economic benefits. This plan would incur the largest social disruption during the construction phase.
<u>ENVIRONMENTAL IMPACTS:</u>	Would require additional mitigation for Valle Verde channel (Reach 4B). Higher mitigation costs and potential for disturbing prehistoric sites. Potential environmental effects have not been analyzed at the final feasibility phase level of detail.	would have the greatest impacts upon the riparian habitat. This plan would incur the greatest mitigation costs and risk of disturbing undocumented prehistoric sites. Potential environmental effects have not been analyzed at the final feasibility phase level of detail.	Not acceptable - No net economic benefits. This plan would incur the largest social disruption during the construction phase.
<u>ADMINISTRATIVE FEASIBILITY:</u>	Acceptable to local sponsor and other government agencies. There are potential concerns for loss of riparian habitat by environmental agencies.	Acceptable - Same concerns as alternative 3A.	Not acceptable - No net economic benefits. This plan would incur the largest social disruption during the construction phase.
<u>CONSTRUCTION FEASIBILITY:</u>	Local sponsor could not contribute 100% of construction cost above NEB plan. Sponsor indicates they could contribute on a 25-25% (25% local) basis.	Same as alternative 3A.	No construction - No net economic benefits. This plan would incur the largest social disruption during the construction phase.
<u>OPERATION AND MAINTENANCE FEASIBILITY:</u>	Unacceptable - This plan has not been analyzed at the final feasibility phase level of detail and NEPA documents have not been prepared.	Unacceptable - This plan has not been analyzed at the final feasibility phase level of detail and NEPA documents have not been prepared.	No construction - No net economic benefits. This plan would incur the largest social disruption during the construction phase.

LEGEND

- |— NOGALES WASH STUDY AREA
- - - - - INTERNATIONAL BOUNDARY
- ...→ TRIBUTARIES SIGNIFICANT TO POTENTIAL PLAN

MEASURES INCORPORATED

-  LATERAL COLLECTOR CHANNEL
-  INCREASED CHANNEL CAPACITY RESULTING FROM LATERAL COLLECTOR CHANNELS
-  OPEN CONCRETE/GROUTED STONE CHANNEL
-  SELF REPORTING RAIN GAGE
-  SELF REPORTING STREAM GAGE
-  SELF REPORTING STREAM GAGE WITH SIREN
-  EXISTING COVERED CONCRETE CHANNEL SYSTEM
-  EXISTING OPEN CONCRETE CHANNEL SYSTEM



PROPOSED STRUCTURAL MEASURES

1. 33 YEAR LATERAL COLLECTOR CHANNELS
2. 100 YEAR CHULA VISTA CHANNELS



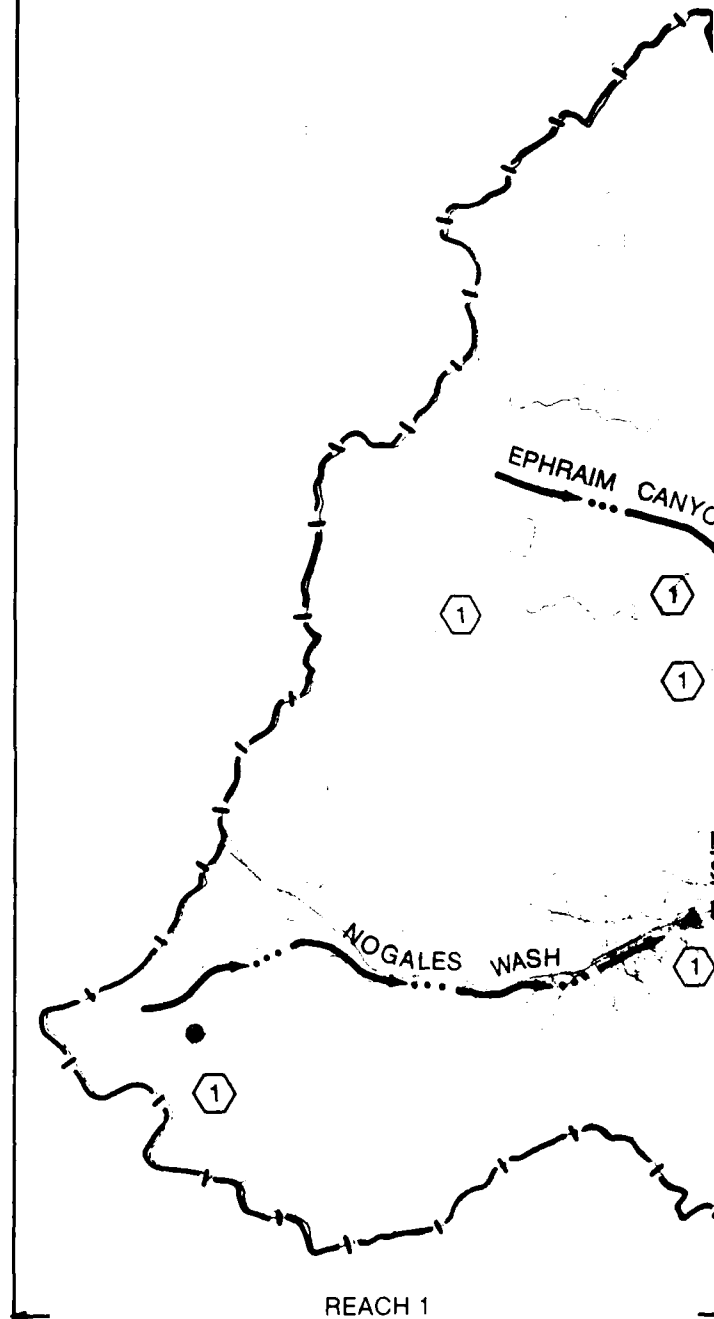
PROPOSED NON-STRUCTURAL MEASURES

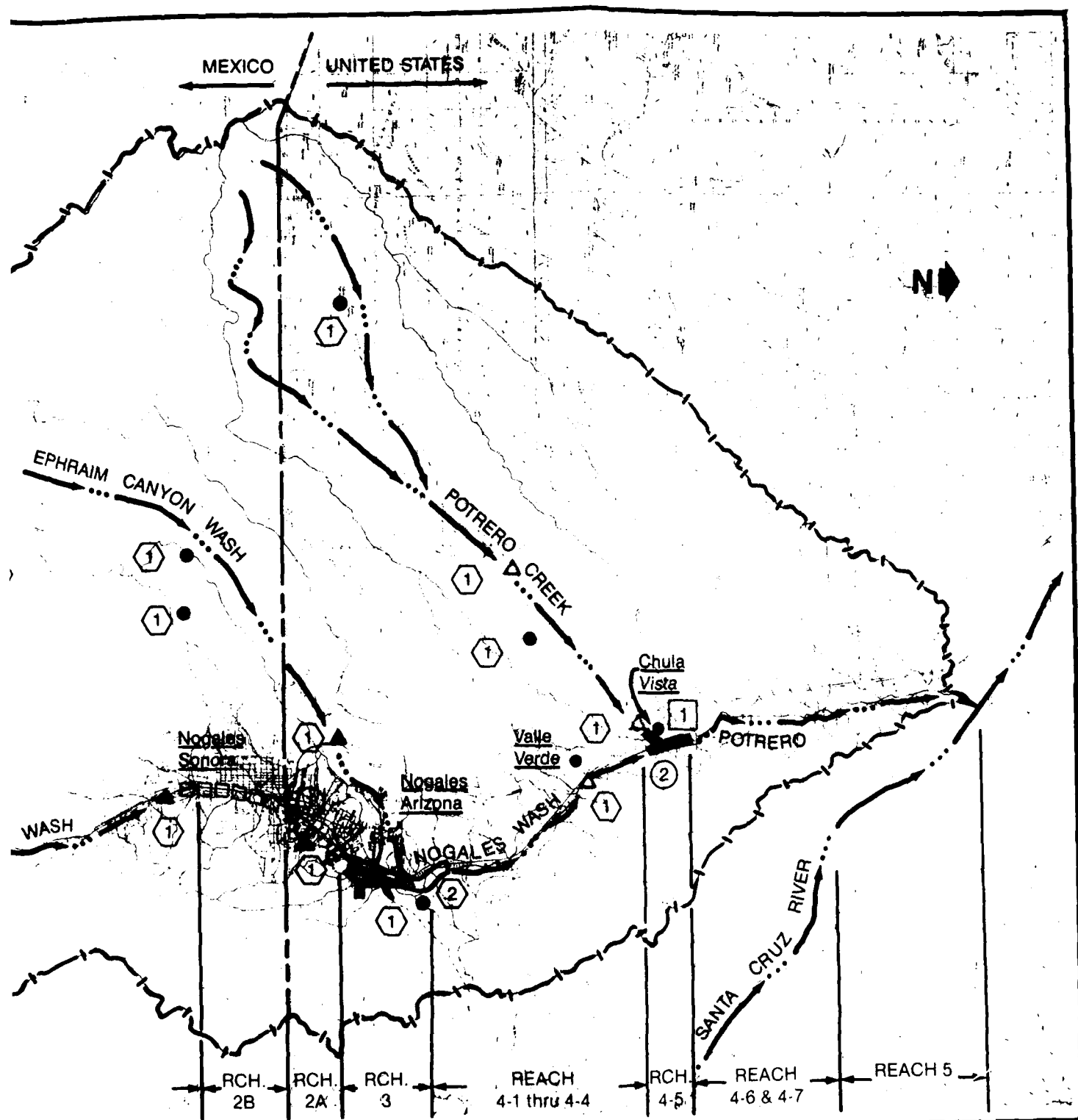
1. FLOOD WARNING SYSTEM COMPONENTS
2. FLOOD WARNING SYSTEM OPERATIONS CENTER SANTA CRUZ CO. SHERIFF



RECREATION MEASURES

1. CHULA VISTA RECREATION PLAN





0' 4000' 8000' 16000'

Scale: 1" = 8,000'0"

Figure 23
NOGALES WASH STUDY
ALTERNATIVE #1

LEGEND

- |— NOGALES WASH STUDY AREA
- INTERNATIONAL BOUNDARY
- ...→ TRIBUTARIES SIGNIFICANT TO POTENTIAL PLAN

MEASURES INCORPORATED

- ||||| LATERAL COLLECTOR CHANNEL
- ||||| INCREASED CHANNEL CAPACITY RESULTING FROM LATERAL COLLECTOR CHANNELS
- OPEN CONCRETE/GROUTED STONE CHANNEL
- SELF REPORTING RAIN GAGE
- ▲ SELF REPORTING STREAM GAGE
- △ SELF REPORTING STREAM GAGE WITH SIREN
- EXISTING COVERED CONCRETE CHANNEL SYSTEM
- === EXISTING OPEN CONCRETE CHANNEL SYSTEM

#

PROPOSED STRUCTURAL MEASURES

1. 33 YEAR LATERAL COLLECTOR CHANNELS
2. 20 YEAR CHULA VISTA CHANNELS

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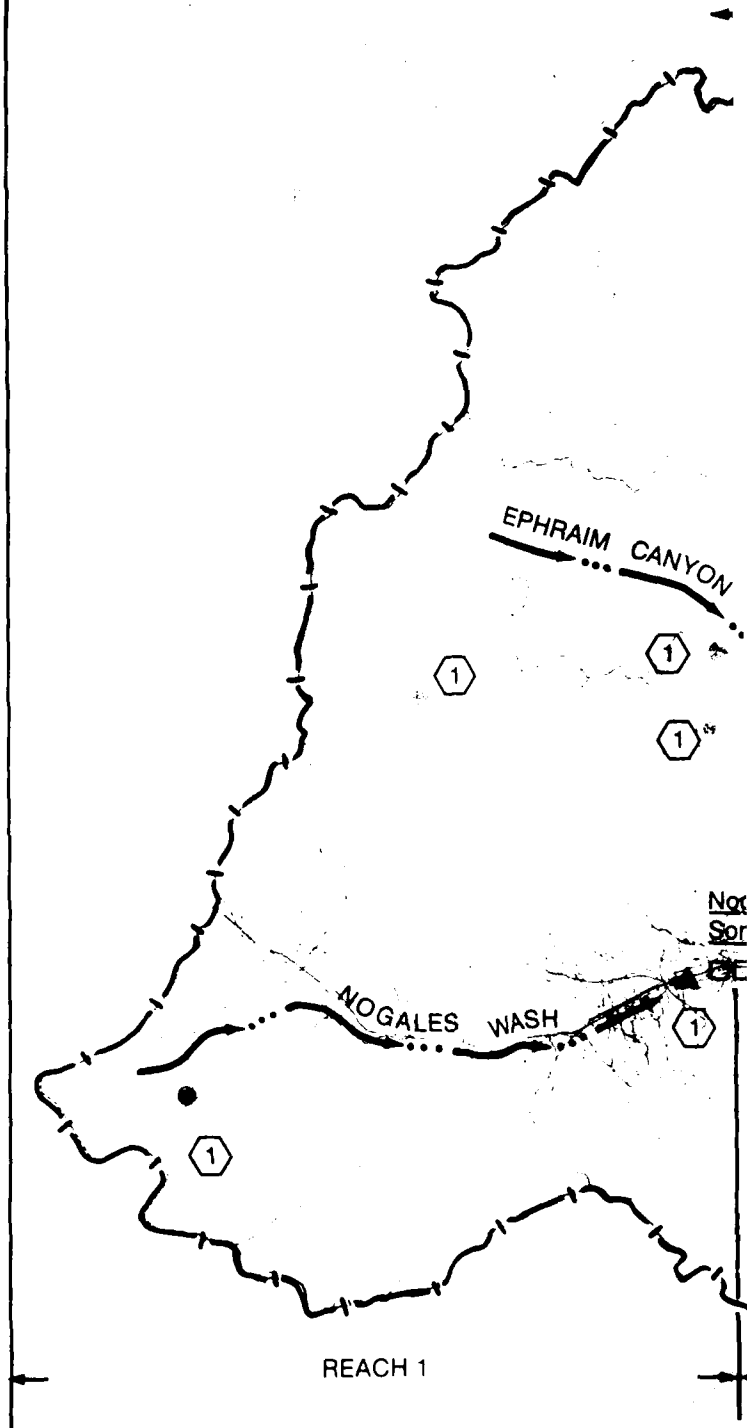
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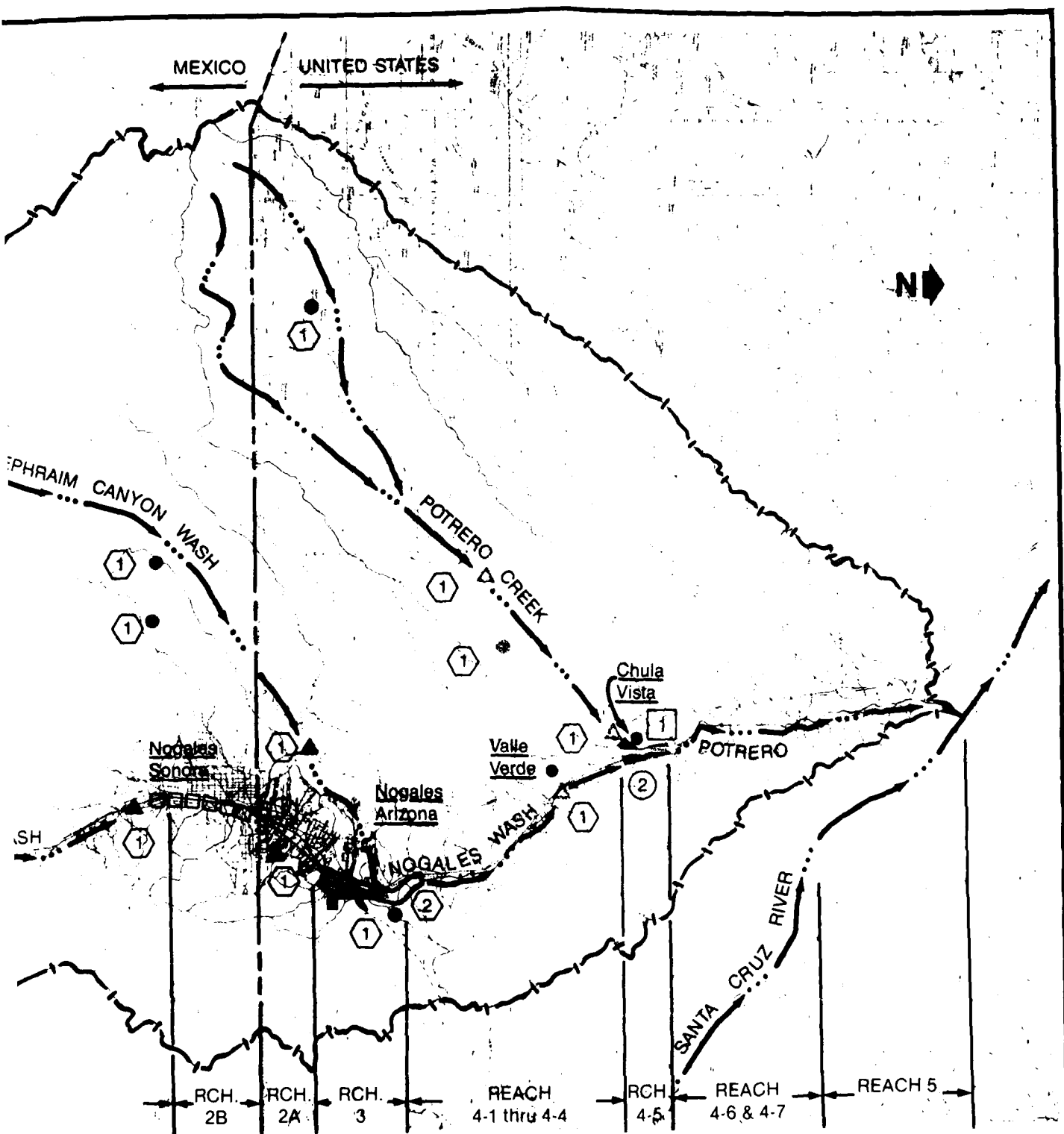
1. FLOOD WARNING SYSTEM COMPONENTS
2. FLOOD WARNING SYSTEM OPERATIONS CENTER SANTA CRUZ CO. SHERIFF

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RECREATION MEASURES

1. CHULA VISTA RECREATION PLAN





0' 4000' 8000' 16000'











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Figure 24
NOGALES WASH STUDY
ALTERNATIVE #2

LEGEND

- |— NOGALES WASH STUDY AREA
- - - - - INTERNATIONAL BOUNDARY
- ...→ TRIBUTARIES SIGNIFICANT TO POTENTIAL PLAN

MEASURES INCORPORATED

-  LATERAL COLLECTOR CHANNEL
-  INCREASED CHANNEL CAPACITY RESULTING FROM LATERAL COLLECTOR CHANNELS
-  OPEN CONCRETE/GROUTED
-  ADDITIONAL COVERED CONCRETE CHANNEL
-  STONE CHANNEL
-  SELF REPORTING RAIN GAGE
-  SELF REPORTING STREAM GAGE
-  SELF REPORTING STREAM GAGE WITH SIREN
-  EXISTING COVERED CONCRETE CHANNEL SYSTEM
-  EXISTING OPEN CONCRETE CHANNEL SYSTEM



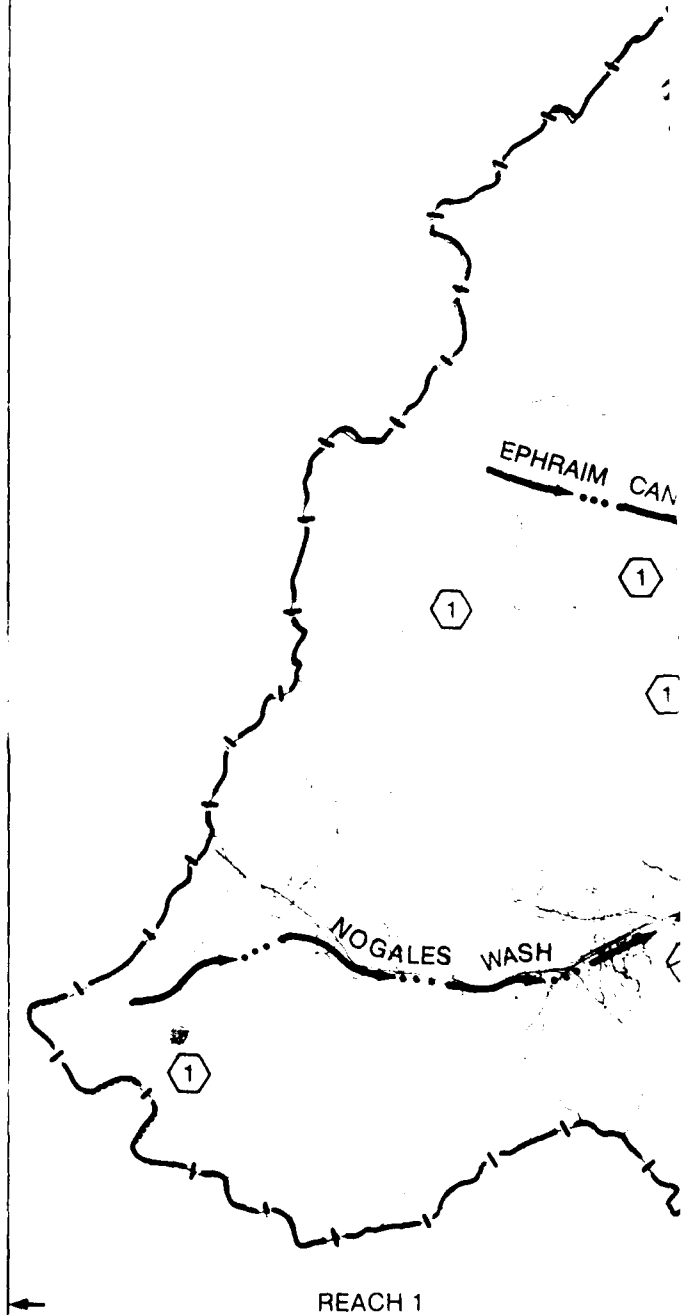
PROPOSED STRUCTURAL MEASURES

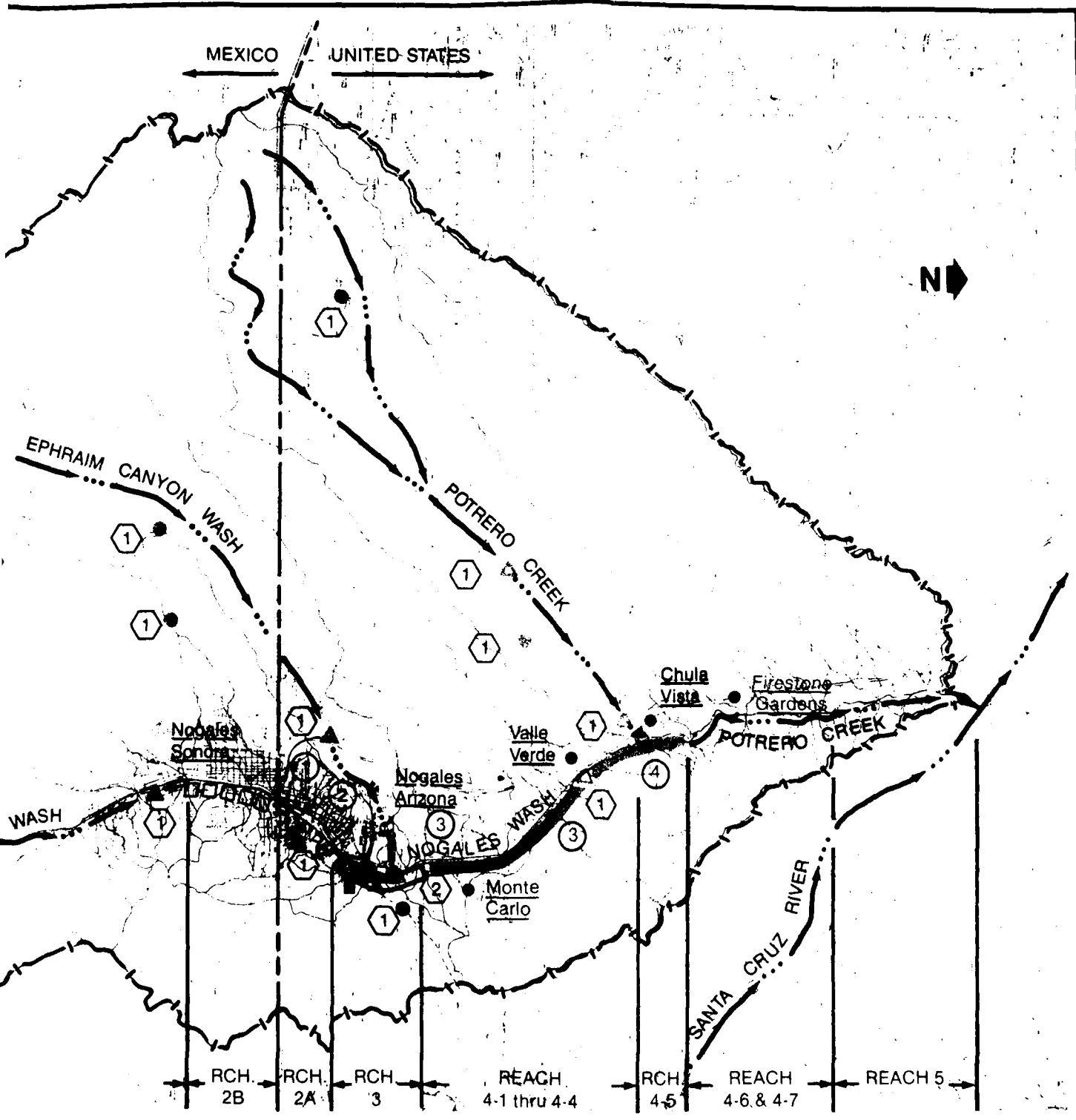
1. 100 YEAR LATERAL COLLECTOR CHANNELS
2. ADDITIONAL COVERED CHANNEL TO PROVIDE 100 YEAR TOTAL CAPACITY
3. 100 YEAR CHANNEL IN REACHES 4-1 THRU 4-4
4. 100 YEAR CHULA VISTA CHANNELS



PROPOSED NON-STRUCTURAL MEASURES

1. FLOOD WARNING SYSTEM COMPONENTS
2. FLOOD WARNING SYSTEM OPERATIONS CENTER
SANTA CRUZ CO. SHERIFF





0' 4000' 8000' 16000'

Scale: 1" = 8,000'0"

Figure 25
NOGALES WASH STUDY
ALTERNATIVE #3A

LEGEND

- |— NOGALES WASH STUDY AREA
- - - - - INTERNATIONAL BOUNDARY
- ...→ TRIBUTARIES SIGNIFICANT TO POTENTIAL PLAN

MEASURES INCORPORATED

- 8 LATERAL COLLECTOR CHANNEL
- ||||| INCREASED CHANNEL CAPACITY RESULTING FROM LATERAL COLLECTOR CHANNELS
- OPEN CONCRETE/GROUTED STONE CHANNEL
- == INCREASED CAPACITY OF EXISTING OPEN CHANNEL SYSTEM
- ADDITIONAL COVERED CONCRETE CHANNEL
- SELF REPORTING RAIN GAGE
- ▲ SELF REPORTING STREAM GAGE
- △ SELF REPORTING STREAM GAGE WITH SIREN
- EXISTING COVERED CONCRETE CHANNEL SYSTEM



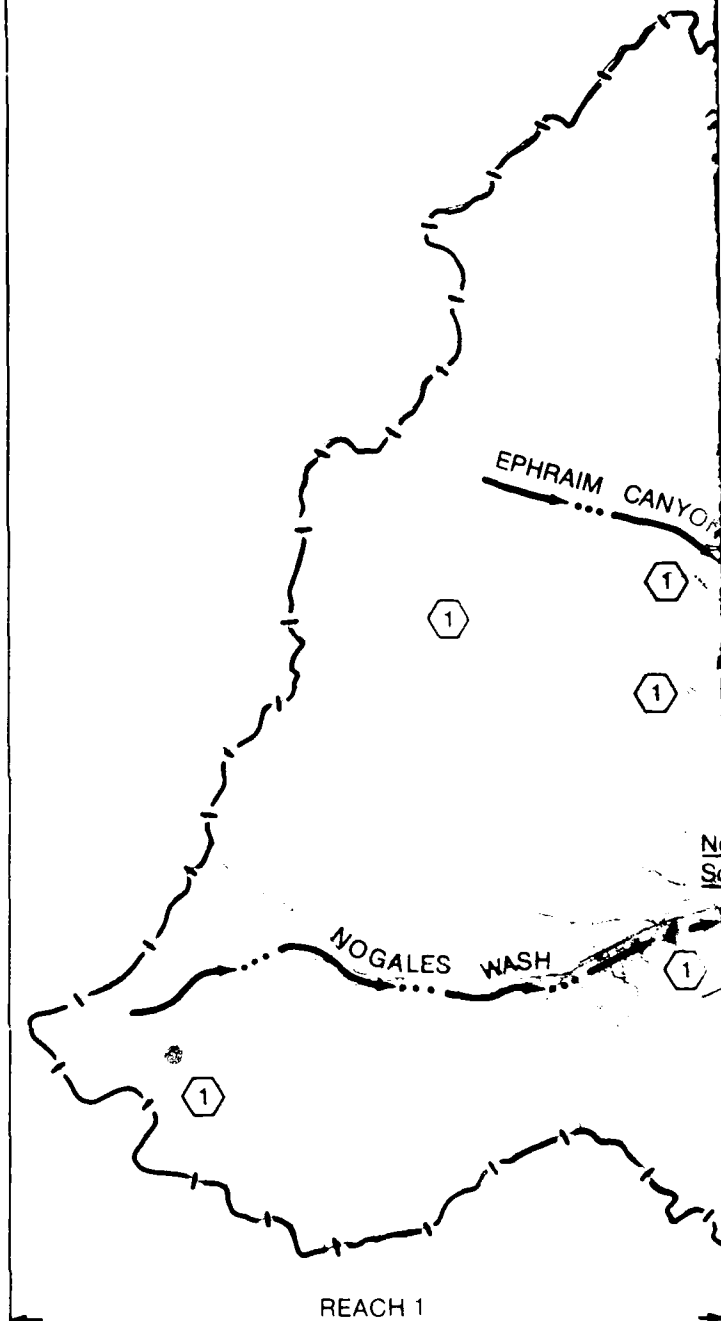
PROPOSED STRUCTURAL MEASURES

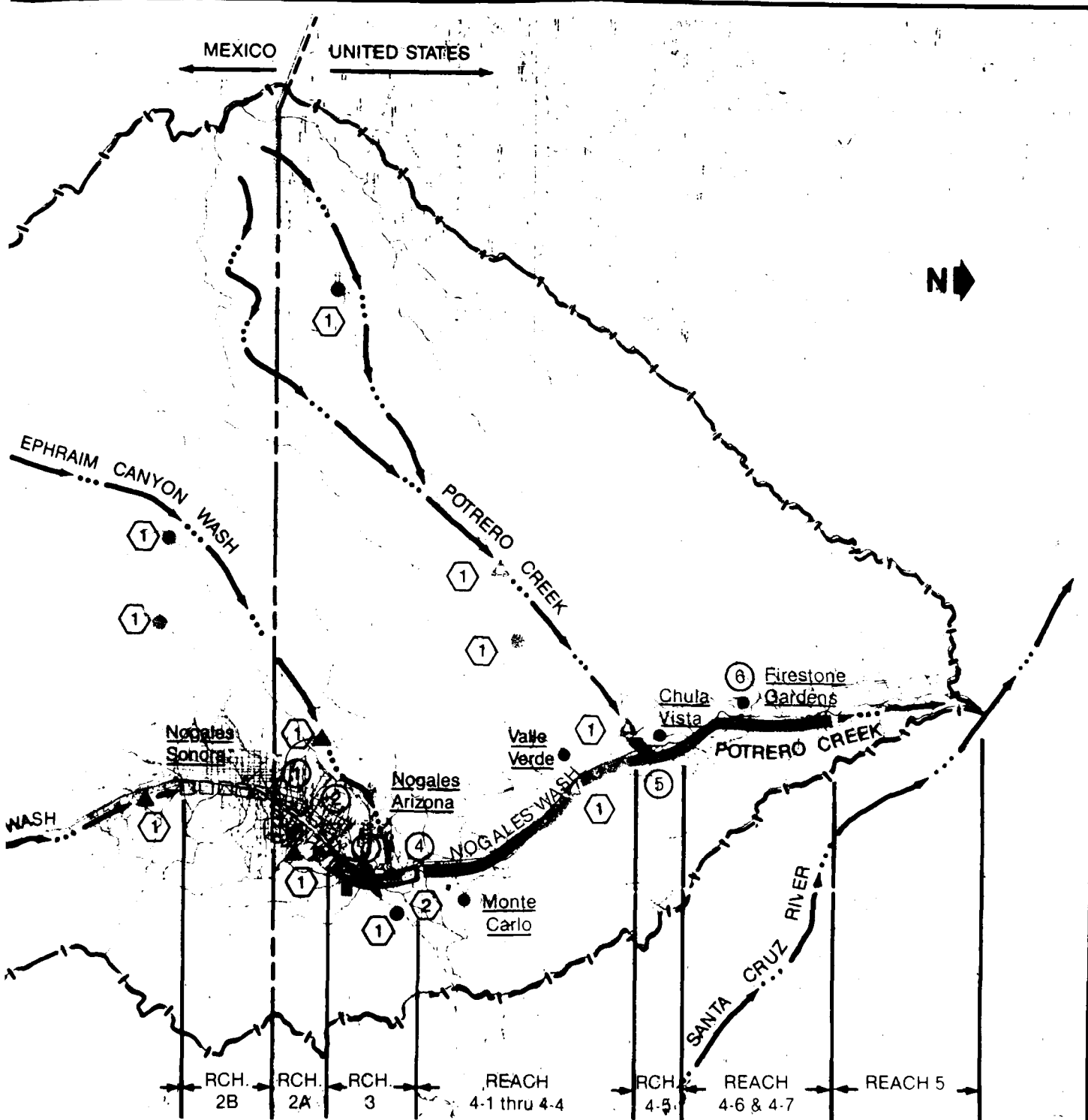
1. 100 YEAR LATERAL COLLECTOR CHANNELS
2. ADDITIONAL COVERED CHANNEL TO PROVIDE 100 YEAR TOTAL CAPACITY
3. INCREASED CAPACITY 100 YEAR OPEN CHANNEL
4. 100 YEAR CHANNEL IN REACHES 4-1 THRU 4-4
5. 100 YEAR CHULA VISTA CHANNELS
6. 100 YEAR CHANNEL IN REACHES 4-6 & 4-7



PROPOSED NON-STRUCTURAL MEASURES

1. FLOOD WARNING SYSTEM COMPONENTS
2. FLOOD WARNING SYSTEM OPERATIONS CENTER SANTA CRUZ CO. SHERIFF





CHAPTER V

RECOMMENDED PLAN

A. GENERAL

This section contains a description of the "Recommended Plan", which was formulated and identified in the preceding section. A general description of plan components and accomplishments is included, as well as significant design, construction, and operation and maintenance aspects. The plan will provide flood protection, recreation, and preserve fish and wildlife resources in the study area.

B. PLAN DESCRIPTION

1. Flood Control Features

a. Lateral collector channels

The lateral collector channels (LCC)s would be located just north of the International Boundary in the City of Nogales. The channels would intercept the Nogales Wash 33-year future condition/44-year present condition flows emanating from Mexico.

The west lateral collector channel would be an entrenched concrete structure extending 162 feet across Grand Avenue/Arroyo Boulevard. It would have an open rectangular cross section with an inside width of 26 3/4 inches and walls varying from approximately 7 to 11 feet in height. The channel which would be covered with a steel grate, would discharge into (1) two 66-inch diameter reinforced-concrete pipes with average lengths of 52 feet, (2) three 72 inch diameter reinforced-concrete pipes with an average length of 162 ft., and (3) one 72 inch diameter reinforced-concrete pipe 105 feet in length. The first five pipes would discharge through flap gates into the existing Arroyo Boulevard covered channel. The last pipe would discharge through a flap gate into the existing Nogales Wash covered channel under Robbins Avenue.

The east lateral collector channel would be a 484 foot long entrenched-concrete structure located adjacent to the north side of the International Boundary fence. It would have an open rectangular cross section with an inside width of 4 feet. Its north wall, which would be 5.5 feet high, would protrude approximately 2.5 feet above the street surface for a distance of 344 feet from the upstream end. Its south wall would vary from 2.17 to 5.5 feet in height, with the top matching the street surface. The channel would discharge into a 59 foot long 48 inch diameter reinforced-concrete pipe. The pipe would discharge through a flap gate into the existing Nogales Wash covered channel under Robins Avenue. A 6 foot high safety fence would be placed on the north wall, and a 53 foot long steel grate would be placed over the channel at the pedestrian crossing adjacent to the guard house. In flood stage, the channel would cause lower water surface elevations in Mexico, up through the 200-year

flood, as compared to without project conditions. Only the 500-year event may result in an increased water surface there. This effect could be avoided by lowering the channel invert by 1 foot. It was determined that debris would collect in the International Boundary fence during flood stage, however, the fence would not fail and would not affect the operation of the collector channels. No attempt would be made to keep the fence clear of debris.

b. Chula Vista channels

The Chula Vista channels (CVC)s would be located to the south and east of the Chula Vista community. The channels would intercept the combined 100-year future condition/125-year present condition Nogales Wash and Potrero Creek flows (60% of which emanate from Mexico), convey these flows around the subdivision, and then discharge the flows back into the natural streambed of Nogales Wash just north of the community.

The Chula Vista/Potrero interceptor channel (CVPIC) is a 692 foot long grouted-stone channel and levee with a trapezoidal cross section. The CVPIC would tie into a hill which forms the west valley boundary and would extend eastward to just west of the Old Tucson Highway. This reach of channel would have a base width varying from 30 to 60 feet. The south side slope height of the channel would vary from about 10.5 to 13.6 feet, and the north side slope height of the channel would vary from 18 to 22 feet. The levee would vary in height above the existing ground surface from about 5.1 to 12.1 feet and have a top width of 15 feet. The channel (including a 2 foot deep cutoff along the north side) and the levee (including the top and outside slope with a 10 foot deep toe) would be completely revetted with a 12 inch thick layer of grouted stone. All side slopes would be 1 vertical on 2 horizontal.

Incorporated into the CVPIC is a 250 foot long low flow pipe (a 36 inch diameter pipe with a controlled inlet grate sized to restrict flow to a maximum of 25 cfs with 8 feet of head). This pipe would allow the perennial flows of Potrero Creek (typically less than 5 cfs) to flow through the existing downstream incised channel instead of being diverted into the interceptor channel. This feature is for aesthetic treatment purposes.

Downstream of the CVPIC, the Chula Vista/Nogales Wash reach of the channel (CVNWC), which is a 1,428 foot long concrete channel with a rectangular cross section (except for the transitions at the upstream and downstream ends), would convey flows from the CVPIC along the east side of Chula Vista. The CVNWC would have an inside width of 65 feet (in the rectangular portion) and wall heights ranging from 11 to 21.5 feet. Berm widths on both sides of the channel would be 15 feet, and cut and fill slopes would be 1 vertical on 2 horizontal. A 6 foot high chain-link safety fence would be required on top of the channel walls.

Below the CVNWC, a 450 foot long grouted stone outlet structure with a trapezoidal cross section would function as an energy dissipator. This reach would have a base width varying from 65 to 150 feet and wall heights varying from 8.5 to 18 feet. It would have 15 foot wide berms on each side and 1 vertical on 2 horizontal side slopes. The channel would be revetted with an 18 inch thick rough grouted rock layer.

LEGEND

- |— NOGALES WASH STUDY AREA
- - - - - INTERNATIONAL BOUNDARY
- ...→ TRIBUTARIES SIGNIFICANT TO POTENTIAL PLAN

MEASURES INCORPORATED

- LATERAL COLLECTOR CHANNEL
- INCREASED CHANNEL CAPACITY RESULTING FROM LATERAL COLLECTOR CHANNELS
- OPEN CONCRETE/GROUTED STONE CHANNEL
- SELF REPORTING RAIN GAGE
- SELF REPORTING STREAM GAGE
- SELF REPORTING STREAM GAGE WITH SIREN
- □ □ □ EXISTING COVERED CONCRETE CHANNEL SYSTEM
- == EXISTING OPEN CONCRETE CHANNEL SYSTEM

PROPOSED STRUCTURAL MEASURES

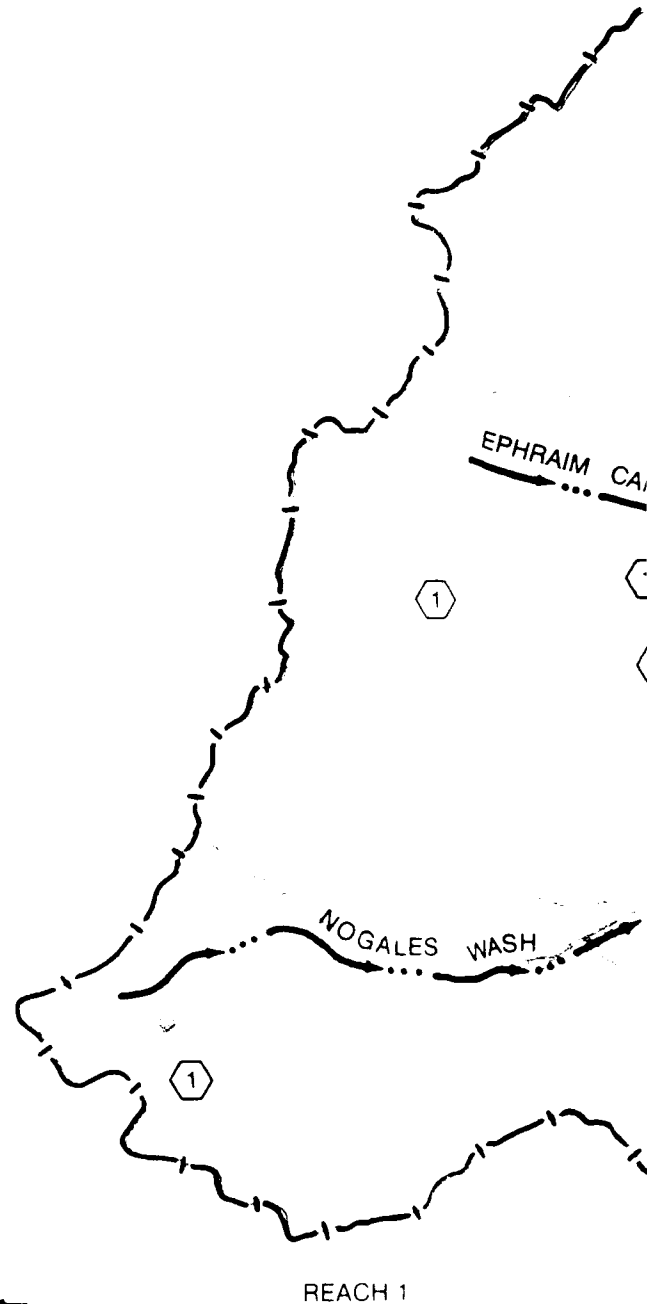
1. 33 YEAR LATERAL COLLECTOR CHANNELS
2. 100 YEAR CHULA VISTA CHANNELS

PROPOSED NON-STRUCTURAL MEASURES

1. FLOOD WARNING SYSTEM COMPONENTS
2. FLOOD WARNING SYSTEM OPERATIONS CENTER
SANTA CRUZ CO. SHERIFF

RECREATION MEASURES

1. CHULA VISTA RECREATION PLAN



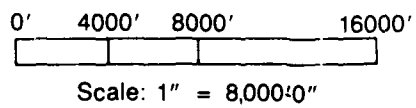
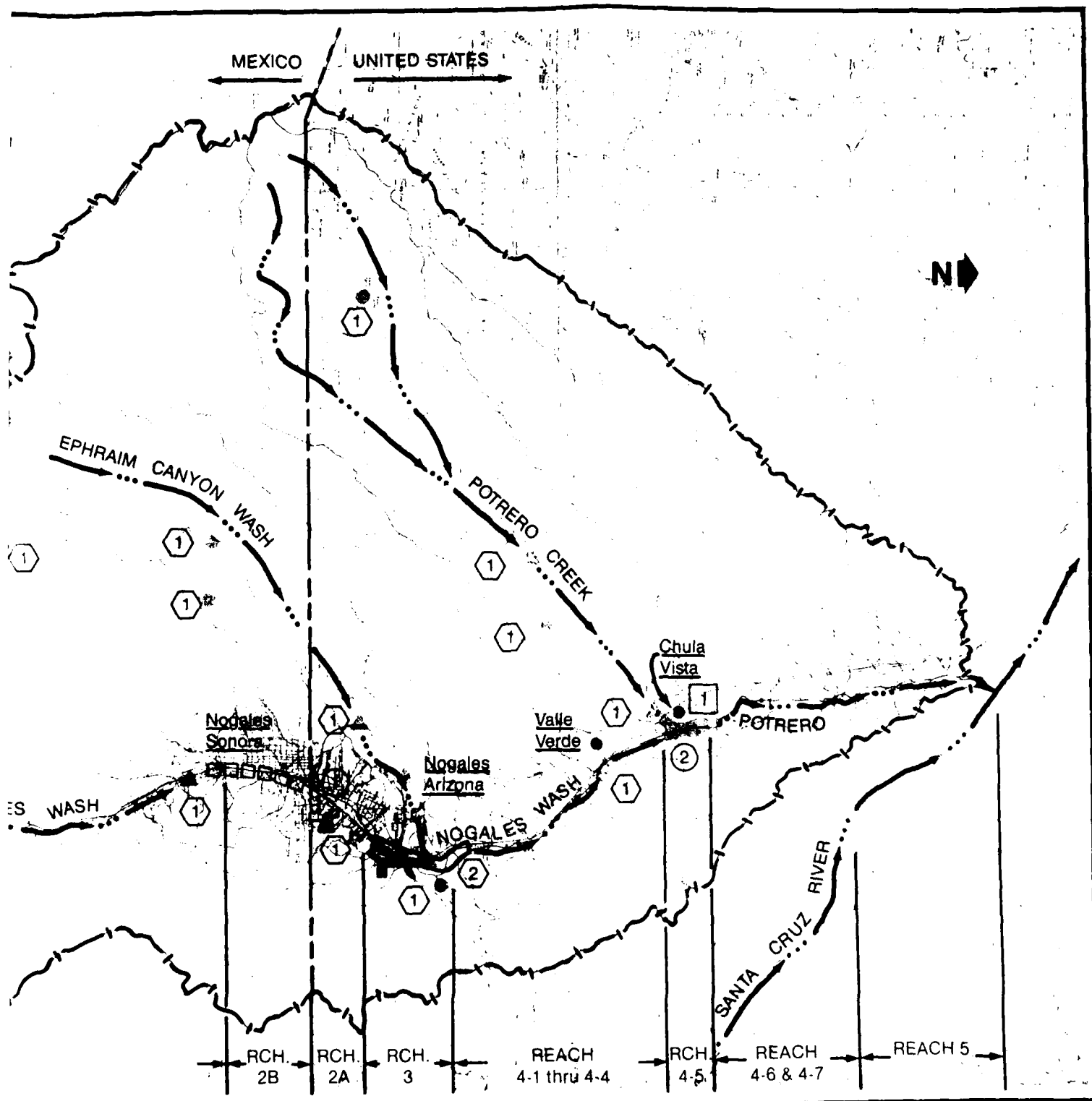


Figure 27
NOGALES WASH STUDY
RECOMMENDED PLAN

Following the energy dissipator, an 800 foot long unlined channel with a trapezoidal cross section, would function as an outlet to the natural streambed of Nogales Wash. This reach would have a base width varying from 150 to about 20 feet at the downstream end where it would daylight with the existing streambed. Side slopes would be 1 vertical on 2 horizontal.

c. Flood warning system

The flood warning system (FWS) would consist of components located throughout the Nogales Wash/Potrero Creek drainage basin. The FWS would cover approximately 76 square miles (80% of the 94.4 square mile drainage area, to include portions of Mexico). The FWS would consist of (7) self reporting rain gages located in the United States and Mexico, (3) self reporting stream gages in the United States and Mexico, (3) self reporting stream gages with sirens located within the United States, (1) one fully equipped repeater including receiving antenna, (a microcomputer for quick interrogation and storage of pertinent data (before and after data retrieval), and additional equipment for use at the command headquarters. The system would provide the latest in hardware for control of water level alerting devices as well as self-reporting rain gages, and would be tied into weather forecasting systems within the general vicinity. Installation of components, and ongoing operation, maintenance, and replacement of components in Mexico would require coordination and assistance from the International Boundary and Water Commission and/or local governments on both sides of the border. Lands which may be required for placement of facilities in Mexico, will be a Federal responsibility; not a local responsibility as is usually the case.

2. Recreation Features

The recreation plan consists of (3) picnic sites and the use of a 1,580 foot long paved access road for bicycling/hiking on project lands for the Chula Vista channels. Each picnic site would include a concrete slab, picnic table, grill, and shelter structure. The picnic sites are located on project lands. As a result, equal access would be provided to all, however, it is anticipated that the recreation facilities would be used primarily by residents living within walking distance. On-street parking would be available for others. The picnic activities are not expected to adversely effect the mitigation plan. The bicycling/hiking activity will make use of the project service road which is within the channel rights-of-way (see Figure 22).

The economic benefits of the recreation facilities were determined using the estimated annual recreation days provided, in relationship with a "unit day value". This method was chosen since 1) no applicable regional model was available, 2) specialized recreation activities were not included, 3) estimated annual visits are less than 750,000, and 4) the recreation facilities are a minor component of the recommended plan in comparison to other project outputs and costs.

3. Fish and Wildlife Mitigation Features

It had been determined that with the proposed environmental commitment to mitigate the project related loss of riparian habitat in the Chula Vista project area, as described in the attached EA, there would not be significant impacts resulting from the Recommended Plan. The proposed Mitigation Plan would utilize riparian species of trees in the channel rights-of-way where aesthetic treatment normally takes place (an area of approximately 2.7 acres). As a result, these plantings would serve a dual purpose. Additional stands of existing riparian vegetation along Potrero Creek (approximately 8.3 acres) will also be obtained in fee or perpetual easement to attain the remaining mitigation requirement. The passive recreation activities are not expected to adversely effect the mitigation plan. Figure 22 illustrates the mitigation and recreation plans.

The quantitative analysis for mitigation requirements was made using a Habitat Evaluation Procedure (HEP). A without project analysis was made to determine the average annual value of the riparian habitat that would be effected by the proposed project. The period of analysis was 100 years and the projected loss of habitat due to ongoing erosion was taken into account. The HEP procedure was also used to determine the with project (without mitigation) value of riparian habitat over the same time period and considering reduced loss of habitat due to erosion. The net loss of habitat as a result of the project would be the mitigation goal. The mitigation plan as provided above will ensure no net loss of riparian habitat.

4. Aesthetic Treatment

Aesthetic treatment will be incorporated into the design of the lateral collector channels. The proposed fence to be located on the north side of the east collector channel, would be color coded and tie into a design of super graphics used for the grating of the west collector channel.

As described in section 3. above, aesthetic treatment will be accomplished within the proposed channel rights-of-way in the Chula Vista project area. Riparian species of trees will be used in lieu of non-riparian species that might otherwise be used. This will provide a portion of the credit for mitigation. Also, the low flow pipe as described in Section B.1.b above would be incorporated as an aesthetic treatment feature. This feature would allow the typical perennial flows of Potrero Creek to flow through the existing channel.

5. Cultural Resources

If "National Register of Historic Places" eligible properties are found during archaeological testing, plans for avoidance and/or data recovery mitigation will be developed and implemented in consultation with the State Historic Preservation Officer.

C. PLAN ACCOMPLISHMENTS

Plan accomplishments are illustrated in Table 23, the System of Accounts, and described below.

1. Flood Control

In part, this plan would provide 33-year future level of protection at the International Boundary from flood flows in Nogales Wash emanating in Mexico. The entire Reach 2A would receive this same benefit, however, damages currently attributed to interior side drainage would remain unchanged. The net affect of this portion of the plan (the lateral collector channel) is an increase in the usable capacity of the existing covered channel system by 2750 cfs. Although the plan is designed to provide 33-year future level of protection, benefits would accrue from floods greater than 33-year, since the plan would reduce the flood stage in Reach 2A.

The plan would also provide 100-year future level of protection in the Chula Vista community. The net affect of this portion of the plan (the Chula Vista channels) is an increase in the combined channel capacity of Nogales Wash and Potrero Creek (in the project area) from 2,300 cfs to 25,000 cfs. Damages from interior drainage would be minimal and would not be affected by the project. Although this portion of the plan is designed to provide 100-year future level of protection, benefits would accrue from floods greater than 100-year since the plan would reduce the flood stage in the Chula Vista community. This plan would include the replacement of one existing bridge (the Old Tucson Highway

TABLE 23. System of Accounts, Recommended Plan

ITEM	NO ACTION ALTERNATIVE	RECOMMENDED PLAN
OTHER SOCIAL EFFECTS		
1. Displacement of People	Temporary and permanent evacuations due to ongoing flooding and bank erosion.	Displacement would be reduced. No displacement resulting from construction of plan.
2. Recreation Opportunities	Development of future recreation facilities is uncertain.	Would provide a small decrease in the existing recreation demand.
3. Transportation	Continues flood, erosion, and closure threat to roadways, bridges, and railroad along Nogales Wash/Potrero Creek.	Reduced threat to transportation facilities in downtown Nogales and Chula Vista community.
4. Employment	Labor force is expected to increase with the increase in business and industry. Unemployment is expected to remain high.	Jobs will be created during construction period resulting in reduced unemployment. Less disruption to work force due to flood-related damages.
5. Public Services	Police, fire, ambulance, and water services and general transportation would be interrupted by floods.	Interruptions caused by flood-related damages would be reduced substantially.
REGIONAL ECONOMIC DEVELOPMENT		
1. Local Government Finance	Flood fight funding will continue. Loss of property tax revenue could occur due to continued flood damages and property degradation.	Local governments must finance their share of project and pay all Operation and Maintenance costs. Emergency flood fighting costs would be reduced. Loss of property taxes due to flood damages would be reduced.
2. Land Development	Community development will continue to be restricted by the lack of developable lands outside the floodway. Property values would remain depressed because of frequent flooding.	Approximately 25 acres of flood prone lands would be removed from the floodway and could be developed for highest and best use. Depressed land values would be relieved.
3. Business and Industry	Tourism industry, International trade and commerce (including produce), and local retail and wholesale activities would continue to be impacted by flooding and the threat of flooding. bridges would continue.	Impacts would be reduced substantially by flood control features and flood warning system.
5. Safety	Without project conditions will not relieve the significant flood threat to human life, safety, and property.	Safety will be significantly enhanced in downtown and Chula Vista communities by flood control features and flood warning system.
6. Energy	Energy consumption would continue to be high during flood fights and as a result of transportation delays.	Some increase in energy consumption during construction period. Decrease in consumption due to less flood fighting and less transportation delays.

TABLE 23. System of Accounts, Recommended Plan

ITEM	NO ACTION ALTERNATIVE	RECOMMENDED PLAN
PLAN DESCRIPTION	No action to be taken by Federal Government to reduce the frequency of flooding by either structural or nonstructural measures.	This plan would provide increased flood protection, flood warning, and recreation features, and will protect portions of the environmental community in the Nogales Wash/Potrero Creek drainage basin.
CONTRIBUTION TO THE PLANNING OBJECTIVE		
1. Flood Control	No contributions to the planning objective.	Would provide 33-year future condition flood protection in downtown Nogales, Arizona community, 100-year future condition flood protection in the Chula Vista community, and flood warning to the Arizona portion of the study area (also potential warning for Mexican community).
2. Recreation	No contribution to the planning objective.	Would provide 3 picnic sites and a bicycling/hiking trail in Chula Vista vicinity.
3. Fish and Wildlife	No contribution to the planning objective.	Would protect portions of the riparian habitat, hence, would protect a portion of the fish and wildlife community in the Chula Vista vicinity.
4. Scenic Values	No contribution to the planning objective.	Involves the use of aesthetic treatment to minimize the impacts on the urban and rural communities. Portions of riparian habitat in Chula Vista vicinity would be preserved.
NATIONAL ECONOMIC DEVELOPMENT (NED)		
1. Total First	None	\$6,020,700
2. Annual Cost	None	\$561,750
3. Annual Benefits	None	\$1,214,750
4. Net Benefits	None	\$653,000
5. B/C Ratio	N/A	2.2:1
ENVIRONMENTAL QUALITY		
1. Riparian Habitat	Some of existing riparian habitat along Nogales Wash/Potrero Creek would be lost to either bank erosion or future development. See attached Environmental Assessment.	Would prevent future loss of riparian habitat due to erosion. Construction would result in temporary loss of existing riparian habitat. Planting program for aesthetic treatment and mitigation of riparian habitat areas would result in no net loss.
2. Agriculture	Existing agriculture lands in the project area would continue to lie fallow due to frequent flooding and bank erosion.	Approximately 20 acres of privately owned fallow lands would be removed from the flood plain and become developable for other purposes. No currently used agricultural lands would be affected.
3. Wildlife	Some loss of riparian habitat would result in the decline of species that make use of this habitat. See attached Environmental Assessment.	Planting program will restore habitat values associated with existing riparian vegetation. Losses associated with bank erosion would be prevented.
4. Rare, Threatened, and endangered species	No action required to protect these species. See attached Environmental Assessment.	No Federally listed threatened or endangered species occur in the study area. Two Federally listed Category 2 candidates have been reported from the area. No impacts on these species are anticipated. See Environment Assessment for potential impact.
5. Water Quality	Increased urbanization, and sewage flow into Nogales Wash could impact groundwater quality.	With project would be same as without project.
6. Aesthetics	Values will decrease somewhat with future development.	Lateral collector channels would have minimal aesthetic impacts. Grouted stone interceptor channel, levee, and concrete channel features of Chula Vista channels would reduce existing rural aesthetic values. Aesthetic treatment would be incorporated into the project with tree planting within the project right-of-way.
7. Cultural Resources	No action required to be taken to preserve these resources.	No known historic properties located within "Area of potential impact" (API). Archeological testing will be accomplished prior to construction to minimize potential impacts in construction phase.

bridge near Chula Vista) which is planned to be replaced by the local sponsor in approximately 5 years even without the proposed project. As such, "advanced replacement of bridges" (ARB) benefits were added into the economic analysis (see Table 26). A new bridge would also be constructed to convey the flows of the Chula Vista interceptor channel under the Old Tucson Highway near the southeast corner of Chula Vista. This second bridge would not provide ARB benefits, although both bridges would be included as project costs.

This Plan would also provide flood warning along the Nogales Wash/Potrero Creek mainstream (the primary benefit area) and in developed areas within Ephraim, Mariposa, and Potrero Canyons (the secondary benefit area). This portion of the plan (the flood warning system) would provide approximately six hours of advanced warning for flooding. This system would allow enough time to fight the flood and hence, significantly reduce flood damage, and would also provide time to evacuate the floodplain, and hence, preserve life.

Approximately 25.54 acres of land (which is currently in the floodway) would be removed from the floodway and could be developed. This removal is incidental to the proposed project (the channel was not designed to accomplish this removal). The increase in land value of this property was included as a location benefit (see Table 26).

The combined plan would reduce the without project average annual damages in the affected project area from \$1,439,000 to \$387,000; a net annual benefit in flood reduction of \$1,052,000. Tables 24A and 24B illustrate these accomplishments.

2. Recreation

A portion of the unmet recreation demand would be supplied by the proposed recreation facilities in the Chula Vista project area. The current unmet demand in the Nogales Arizona community is 832,000 (without project) and 878,801 (with project) recreation user days. The proposed improvements would supply 3,199 recreation user days, reducing the total deficit to 878,801 recreation user days.

3. Environmental

Although a portion of the existing riparian habitat would be lost as a result of the project, mitigation measures would be taken to replace this habitat with no annualized net loss over the life of the project.

4. Fish and Wildlife

Fish and wildlife species making use of the existing riparian habitat would also be temporarily affected by the construction of the project in the Chula Vista vicinity. There would be, however, no annualized net loss over the life of the project due to proposed mitigation measure.

5. Social

The proposed plan would significantly reduce the real and perceived flood threat to property and human life in the downtown and Chula Vista communities.

**TABLE 24A. Flood Damage Reduction, Lateral Collector And Chula Vista Channels
(October 1986 Price Levels @ 8 7/8%)**

LOCATION	SELECTED FLOOD EVENT (\$x1,000,000 Rounded)							Average Annual
	10yr	20yr	30yr	50yr	100yr	200yr	500yr	
Segment 2A								
Channel Collector								
Annual Property Damages	4.0	4.0	3.7	3.0	2.3	1.6	2.0	3.1
Annual Business Damages	0.7	1.0	1.1	1.1	0.5	0.4	0.4	0.8
Annual Total Damages	4.7	5.0	4.8	4.1	2.8	2.0	2.4	3.9
Segment 2B								
Channel Collector								
Annual Property Damages	1.1	1.2	1.1	1.1	0.5	0.4	0.4	0.8
Annual Business Damages	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2
Annual Total Damages	1.2	1.4	1.2	1.2	0.6	0.5	0.5	1.0
Segment 2C								
Channel Collector								
Annual Property Damages	0.7	0.7	0.6	0.5	0.3	0.2	0.2	0.6
Annual Business Damages	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Annual Total Damages	0.8	0.8	0.7	0.6	0.4	0.3	0.3	0.8

**TABLE 24B. Average Annual Economic Effects of Recommended Plan
(October 1986 Price Levels @ 8 7/8%)**

	With Proposed Plan Annual Damages (\$x1,000)	With Proposed Plan Annual Property Damages (\$x1,000)	With Proposed Plan Annual Business Damages (\$x1,000)
Segment 2A	3.9	3.1	0.8
Segment 2B	1.0	0.8	0.2
Segment 2C	0.8	0.6	0.2
Channel Collector	5.7	4.5	1.2
Channel Collector	1.9	1.5	0.4
Channel Collector	1.6	1.2	0.4
Channel Collector	6.3	5.2	1.1
Channel Collector	2.5	2.0	0.5
Channel Collector	2.1	1.7	0.4
Channel Collector	10.9	8.9	2.0

The flood warning system would further decrease the flood threat to human life even further by providing evacuation time throughout the study area.

This plan would also remove approximately 25 acres of vacant or fallow lands from the floodplain. These lands would then be developable and would contribute to the regional economy of the Nogales community. The utilization of the unemployed or underemployed local workforce during the construction phase would also contribute to the local economy on a temporary basis.

There are no known historic properties located within the "area of potential impact" (APE). Archaeological testing, however, will be accomplished prior to construction to minimize the potential impacts in the construction phase.

6. Summary

The Recommended Plan would provide \$1,052,000 in average annual flood control benefits, \$152,000 in average annual benefits associated with the flood control project (employment and location benefits and benefits associated with advanced replacement of a bridge), and \$3,000 in average annual benefits for recreation, for total average annual benefits of \$1,207,000. The plan would also provide other (non-economic) benefits by reducing the flood threat to human life.

D. EFFECTS OF THE PLAN ON THE ENVIRONMENT

The effects of the Recommended Plan on natural resources receiving national recognition and the compliance of the Recommended Plan with environmental statutes are summarized in the attached Environmental Assessment.

E. PROJECT FLOOD CONTROL OPERATION

The flood control operation in Reach 2A has been designed to provide 33-year future condition level of protection to the downtown Nogales Arizona community along Reach 2A. Floodflows at or below this level of protection would be contained within the existing covered channel section (Reach 2A). Below the outlets of the covered channels, the flows would be released into the existing open concrete channel section (Reach 3). Flood flows exceeding the design capacity (7650 cfs) of the existing covered channels, would occur as street flow throughout Reach 2A and into portions of Reach 3. This street flow, however, would be smaller than in a without project condition resulting in lower water surface elevations, lower velocities and less damage potential from the International Boundary to the existing covered channel outlets. For larger events (greater than 33-year future condition) areas below the covered channel outlets may be subject to a slight increase in water surface elevations (less than 0.1 feet), and velocities, as is the case with traditional channel improvements. These increases, however, are not expected to measurably worsen flood damages downstream. Drainage of interior areas in Reach 2A from Nogales Wash flooding would not be adversely affected by this project.

The flood control operation in Reach 4-5 (Chula Vista subreach) has been designed to provide 100-year future condition level of protection to the Chula Vista/Pete Kitchen community. Floodflows at or below this level of protection

would be contained within the project channels. Floodflows will be released into the downstream unimproved section (Reach 4A) via an energy dissipator and outlet structure. For floodflows exceeding the design capacity (2,000 cfs) of the Chula Vista Channels, overtopping would first occur along the eastern 20 feet of the interceptor channel's levee. As flood stages increase, overtopping of the levee would expand to the west. Exceedance flows would be similar without project flows, but smaller in terms of magnitude. Drainage of interior areas within the Chula Vista community would not be adversely affected by this project.

The following discussion will describe in detail the operation of the project during the 33-year, 100-year, and 500-year flood events. Plate 1 illustrates the 100 and 500-year "with project" overflows. This can be compared with the "without" project overflows in Plate 4. Tables 12A through 12D provide the with and without, present and future conditions discharge frequency values at various hydrologic concentration points along the Nogales Wash/Potrero Creek mainstem. All references to residual damages are given in October 1986 price levels with an $8\frac{7}{8}\%$ amortization rate. Table 24A provides a summary of with and without project damages by reach for selected flood events and for average annual conditions in those areas affected by the proposed project.

1. Upstream Section in Mexico (Reach 1)

- a. Project features - none
- b. 33, 100 and 500-year floods

Out of channel flooding would occur and be carried in part by the streets within Nogales, Sonora. The project would have no effect on flooding within this reach.

2. Covered Concrete Channel Section in Mexico (Reach 2)

- a. Project features - none
- b. 33, 100, 500-year floods

The unfilled Nogales Wash covered channel would carry a small portion of the floodflow. The Arroyo Boulevard covered channel which starts at the end of this reach would also be partially filled. Flood flows either discharging or overtopping the inlets would be carried as street flow through the Nogales, Sonora community toward the International Boundary. Future development in the drainage basin is expected to increase the magnitude of these flows. The project would have no effect on flooding within this reach.

3. Covered Concrete Channel Section in the United States (Reach 3)

- a. Project features
 - 33-year lateral collector channel
 - flood warning system
- b. 33-year flood

Channel capacity within this reach would be increased to 7650 cfs by capturing overland flows at the International Boundary and diverting them into the two existing, but unfilled covered channels. Nogales Wash flows would be contained throughout this reach, however, some damage may result from interior side drainage not being allowed into the channels because of their filled condition. As discussed in Section B.1. of this chapter the parapet wall on the north side of the east lateral collector channel would not increase water surface elevations in Mexico for 200 year or less frequent flood events. Impacts from larger events could be eliminated by lowering the invert of the east lateral collector channel by one foot.

c. 100 and 500-year floods

Floods greater than the 33-year future condition flood would pass over the lateral collector channels and flood areas in Reach 2A. The resulting with project overflows would be the same as the without project overflow except for a slightly reduced stage and width. Flood warning would be provided throughout this reach for floods larger than 33-year. The flood warning system would provide some additional time for business concerns to take action to reduce flood damages and to evacuate the flood area.

4. Open Concrete Channel Section (Reach 3)

a. Project features

--flood warning system

b. 33-year flood

Existing channel capacity in this reach would provide protection from the 33-year flood. Some breakout may occur, however, at the Doe Street and banks' bridges, as a result of debris buildup.

c. 100 and 500-year floods

Channel capacity within Reach 3 varies between 30-year and 60-year (future condition). Larger floods would overtop the existing open concrete channel. The 100-year flood would result in approximately \$1,745,000 in damages; the 200-year in \$3,000,000 and the 500-year in \$3,165,000. The flood warning system again would provide additional time for residents and business concerns to fight the flood and/or evacuate.

5. Unimproved Section Upstream of Chula Vista (Reach 4B)

a. Project features

--flood warning

b. 33, 100 and 500-year floods

Floods greater than the 5-year future condition flood would breakout from the existing unimproved channel upstream of Valle Verde (see Chapter 3, Figure 7). These flows spread out through the Valle Verde community and co-mingle with Potrero Creek and the Chula Vista breakouts just upstream of the Chula

Vista community. The 20-year flood would result in approximately \$1,771,000 in damages; the 50-year in 3,671,000, the 100-year in \$5,598,000, the 200-year in \$7,797,000, and the 500-year in \$12,001,000. The flood warning system would provide warning to the Valle Verde community for all levels of flooding since the minimum channel capacity in this reach is less than 5-year.

6. Chula Vista Community (Reach 4-5)

a. Project features

- Chula Vista channels
- flood warning system

b. 33 and 100-year floods

The Chula Vista community would be free of floodflows up to the 100-year level of protection. Breakout flows from Nogales Wash (including flows coming from Valle Verde) would combine with breakout flows from Potrero Creek south of Chula Vista. For a 100-year flood, up to 23,000 cfs of floodflow would be captured by the proposed Chula Vista/Potrero interceptor channel. A portion of this flow would be contained by the levee on the north or downstream side of the interceptor channel. The levee would raise the upstream with project water surface elevation from 0 to 2 feet above the without project water surface elevation at the center line of the interceptor channel. This increased water surface elevation would daylight with the without project water surface elevation within the project right of-way. Flood waters captured by the interceptor channel would be conveyed past the Chula Vista community via the Chula Vista/Nogales Wash channel. This channel is designed to carry the combined Nogales Wash/Potrero Creek floodflow of 25,000 cfs. Just downstream of the Chula Vista community, the project channel would release the floodflows into the existing Nogales Wash streambed via an energy dissipator and outlet channel. These features would reduce the velocity of the flows to compensate for the increase in velocity created by the concrete channel.

c. 500-year flood

A 500-year flood would overtop the levee on the north side of the interceptor channel. Overtopping would start at the east end of the levee and move to the west as the flood stage increases. Stone grouting on all sides of the levee (including a 10 foot deep toe on the north or downstream side) would prevent the levee from failing. Overtopping floodflows would continue in a northwesterly direction through the Chula Vista community and toward the existing Potrero Creek alignment. This flow would then combine with the filled Nogales project channel at the existing confluence area. Flows through the Chula Vista community would be reduced from the without project condition by 23,000 cfs. This would be the result of the increased channel capacity. Flood warning in the Chula Vista vicinity would alert residents not protected by the project of an impending flood. Chula Vista residents would be alerted of floods potentially larger than 100-year.

d. All levels of flooding

In all levels of flooding, the low flow pipe would continue to discharge flow into the Potrero Creek low flow channel at a maximum rate of 25 cfs. The

grated inlet of the low flow pipe would provide a fixed control and would not be manually operated.

7. Unimproved Section Downstream of Chula Vista (Reaches 4A and 5)

- a. Project features
 - flood warning system
- b. 33, 100 and 500-year floods

Floodflows released by the Chula Vista channel would continue downstream as they would without a project. Flows released at the outlet structure would be pointed in a downstream direction so that they would make a uniform westerly curve just below the confluence area. This would reduce the present erosion problem at the confluence area where existing flows emanating from the Potrero Creek alignment make a sharp bend against the east bank of Nogales Wash. Flood flow released from the energy dissipator would have a reduced velocity which would also lessen the potential for bank erosion downstream. Flooding would not be decreased by the project in these reaches. Some damages would occur with flood events as low as 10-year. Within Reach 4A, the 20-year flood would result in \$301,000 in damages; the 50-year in \$711,000, the 100-year in \$953,000, the 200-year in \$1,222,000 and the 500-year in \$1,646,000. The flood warning system would provide warning to residents in the Firestone Gardens vicinity of impending floods.

F. RISK AND UNCERTAINTY

Whether the selected plan will operate in the manner described and provide benefits as stated is dependent on the various assumptions, data base, and analytic techniques used in the study. The data used for forecasted economic, demographic, and environmental conditions are at this time the most reliable assessment of the future. Also, because the evaluation is not dependent on significant projection of land use and dependent primarily on existing developments, there is little risk that changes in this data will have an impact on project accomplishments.

With regard to flood control accomplishments, a degree of uncertainty would exist on the level of protection provided, stemming from the uncertainty inherent in the hydrologic analysis. In view of the extensive hydrologic analysis conducted during this study and the operation of the project, it is believed that any uncertainty is small.

The lateral collector channels are essentially channels designed to capture overland flow emanating from Mexico and divert it into two existing covered channels at the International Boundary. Once these covered channels would be filled to capacity, overtopping would occur. The resulting streetflow through the downtown community would continue to cause damage and risk to human life, but at a lesser degree. This portion of the project does not pose a risk of sudden or catastrophic failure. Analysis conducted in the study found that the future conditions of the covered channel inlets in Mexico would have an effect on the project efficiency, however, (1) future changes are expected to be minimal resulting in only minor effects to the system and (2) even if changes would be significant, the system would continue functioning to reduce flood damage and the threat to human life, (3) changes to inlet conditions are not expected within the near future, (4) the high B/C ratio and short payback

period of the recommended plan provide assurance that potential changes in the inlet condition would not have significant impacts on the economic effectiveness of the system.

In the engineering design of the lateral collector channel, flap gates were used at points of intersection between the existing covered channels and incoming pipes. These flap gates would reduce the potential for the system to emit foul odor, however, they would allow standing water to drain from the pipes back into the existing covered channels. As such, the system would not cause health or sanitary hazards. Trash and debris would have to be removed from both collector channels on a regular basis, although this is not expected to reduce the engineering effectiveness of the system. The grating over the west lateral collector channel will effectively capture overland flow even when 42% of its surface area is blocked with debris.

The Chula Vista channels are essentially entrenched channels with a portion of the flow being contained by a levee. The levee is designed with 3 feet of freeboard for the 100-year level of protection. The levee would also be armored with grouted stone on the land side as well as the river side including a 10-foot toe on both sides. This feature would preclude sudden levee failure and the potential for a catastrophic condition. Flooding from larger than 100-year floods would occur gradually with advanced warning from the flood warning system.

The Recommended Plan includes a flood warning system with three rain gages and one stream gage located in Mexico. If these gages are eliminated from the Recommended Plan, the remaining system would provide some, but reduced, flood warning (areas near the border would have minimal warning; areas further downstream would have greater warning). If the entire system (including components in the U.S.) is eliminated from the plan, the proposed structural flood control components would continue to operate as designed, however, no flood warning would be provided.

G. DESIGN AND CONSTRUCTION CONSIDERATIONS

1. Lateral Collector Channels

The alignment of the lateral collector channels (LCC)s was made as close to the International Boundary as possible to reduce flood damages downstream. The alignment also considered the width of the floodplain, distribution of overland flow and significant features such as roadways, buildings, and adjacent land use. The LCCs design would not require any building modifications or relocations and would be constructed within public lands that would be available to the project at no cost.

The hydraulic design of the LCC system incorporated 2 feet of freeboard in the collectors themselves, and 2 feet within the existing channels that the collectors would fill. Flap gates would be incorporated into all pipes connecting the LCCs with the existing covered channels to reduce the possibility of sewer gas escaping from the covered channels. The entire west LCC would be covered by a structural steel grate to allow for vehicular traffic. The pedestrian crossing in the east valley would also have a grated section over the otherwise open, east LCC. The remaining portion of the open channel would utilize a 6 foot high chain link fence on the north side for

pedestrian safety.

Staged construction and detouring of lanes would be required for the west lateral collector channel in order to maintain vehicular traffic across the International Boundary between the United States and Mexico. A portion of Arroyo Boulevard would have to be blocked for placing the pipes and west end of the channel. Some of the traffic not crossing the boundary would have to be detoured to another street. Some staged construction would be required for the east lateral collector channel to maintain pedestrian traffic across the International Boundary. The southern third of International Street and the southern end of Robins Avenue would have to be blocked. Traffic would have to be detoured for construction of the channel and pipes entering Nogales Wash channel.

Construction would be staged to allow drainage of surface low-flows through the pipes into the existing channels during construction of the lateral collector channels. In addition, a temporary asphalt curb could be constructed along the south side of the construction areas to divert low-flows from street surface.

2. Chula Vista Channels

The alignment of the Chula Vista channels considered the width and depth of the floodplain, lands available for construction and significant features such as existing transportation alignments, buildings, adjacent land use, and location of riparian habitat. Design consideration favored narrow channel widths for the Chula Vista channels, because (1) project lands were typically fee land and would have to be purchased, (2) two project bridges favored narrow spans, and (3) a portion of the Chula Vista/Nogales Wash channel is located within a constricted area between the Southern Pacific railroad embankment and the Old Tucson Highway.

To reduce construction costs of the Chula Vista interceptor channel, design considerations favored a levee to help contain the design flow rather than a "pure" channel concept. The proposed levee would be constructed with the material excavated from the project channels. The entire length of the levee was designed with grouted stone armoring and a 10 foot toe to prevent failure. Due to hydraulic conditions (turbulence and high velocity) the sides and bottom of the interceptor channel would also be armored with grouted stone.

Right-of-way constraints and hydraulic requirements for the Chula Vista/Nogales Wash channel resulted in the design of a rectangular concrete channel. An energy dissipator was incorporated into the design so that super critical channel velocities would be reduced to without project velocities.

A 12 foot wide invert access ramp would be provided at the downstream end of the grouted-stone interceptor channel for routine inspection patrols and maintenance. Paved maintenance roads would also be provided on top of the interceptor levee and on both sides of the concrete channel and outlet structure for inspection and maintenance of the channel. The road would be 10 feet wide and have a 4 inch thick aggregate base paved with a 2 inch thick layer of asphaltic concrete.

Construction would proceed upstream from the downstream end to allow drainage of the construction sites. Perennial Nogales Wash flows and nominal

flood flows would be diverted to one side of the channel with temporary levees during construction of the invert and walls on the opposite side.

Because of high groundwater, dewatering will be required during channel excavation and construction. This would be accomplished with a system of pumps and pipes draining into the temporary channels created by temporary levees. Dewatering of the construction area would not effect adjacent riparian areas.

A subdrainage system comprised of a 12 inch thick gravel layer underlain by a 6 inch sand layer and a 6 inch thick gravel layer underlain by a 6 inch thick sand layer would underlay the grouted stone and concrete inverts, respectively. Six inch diameter perforated pipes would be embedded in the gravel layer along each side of the channel invert.

Dry weather or low flow in Potrero Creek would not be diverted by the Chula Vista interceptor channel. Instead, it would drain into a grated-intake structure. The water would then discharge through a 250 foot long 36 inch diameter reinforced-concrete pipe under the upstream end of Chula Vista interceptor channel. At the downstream end of the pipe it would discharge onto a grouted-stone outlet structure and return to the natural streambed of Potrero Creek. The grated inlet would allow a maximum of 25 cfs to flow through the low flow pipe. This low flow through Pete Kitchen subdivision is considered "pleasant" by residents.

3. Flood Warning System

Self reporting rain gages would be placed throughout the Nogales Wash/Potrero Creek drainage basin for a comprehensive report of precipitation. Of the 7 rain gages incorporated, four are in Mexico. A total of 6 self reporting stream gages are incorporated into the design; one being located in Mexico above the main inlet to the Nogales Wash covered channel. All of the stream gages would be located on either the Nogales Wash/Potrero Creek mainstem or on its major tributaries. The three most upstream gages would not incorporate attached sirens since there is currently a "civil defense" system in place which the flood warning system would be integrated with. The three stream gages further down stream are in areas where there are no existing sirens. As such, sirens will be incorporated into these features. The sirens themselves would be located in the populated areas and tied into the FWS electronically. All of the self reporting gages will be tied to the base system in the sheriff's office via a repeater(s). Exact locations of the gages have not been determined at this time, but their approximate locations are identified on Figure 27. The location of the repeater(s) has not yet been determined. This will be accomplished in the next (PED) phase.

All self reporting gages would require regular testing and battery replacement. This type of equipment has a life expectancy of approximately 20 years. As such, it will have to be replaced several times over the 100-year life of the project.

H. OPERATION AND MAINTENANCE

Total annual operation and maintenance (O&M) costs for the Recommended Plan are \$11,000. The annual O&M costs for the lateral collector channels (LCC)s are estimated at \$1,000. The anticipated future repair of the inverts in two existing covered channels (required to bring the life of the existing channels up to the proposed 100 year project life of the LCC system) would be

accomplished by including the "present value" of \$18,200 for this estimated repair cost (\$1,315,000), into the "first cost of construction" (see Table 25F., Future Repairs/replacements). This "present value" would mature to an amount large enough to pay for this repair in 50 years.

Annual O&M costs for the 100-year Chula Vista channels (CVC)s are estimated at \$7,000. Of this amount, \$2,200 would be used for repair/replacement of the irrigation system (needed for aesthetic treatment) and replacement of riparian trees that are utilized in the aesthetic treatment/mitigation areas (see Figure 22).

Annual O&M charges for the flood warning system are estimated at \$1,000, and would include system testing and battery replacement. These activities would have to be coordinated through the International Boundary and Water Commission for facilities located within Mexico. Replacement of system hardware at approximately 20-year intervals would cost an estimated \$63,000 (each replacement). This would be accomplished by including its "present value" of \$14,100 in the "first cost of construction" (see Table 25F., Future Repairs/Replacement). In 20 years, this amount would mature to the replacement value, and leave \$14,100 to start the cycle again.

Annual O&M and R (replacement) costs for the recreation facilities are estimated at \$2,000.

I. REAL ESTATE REQUIREMENTS

The acquisition of real estate for the project will be the responsibility of the local sponsor. For the lateral collector channels (LCC) right-of-way will be required within the existing 60 foot wide Federal lands adjacent to the International Boundary. Where portions of the LCC system extend beyond the Federal lands (installation of covered concrete transition pipe under city streets) a permit or easement from the City of Nogales will be required.

For the Chula Vista portion of the project, channel rights-of-way will be acquired as fee title or perpetual easement. The same applies for mitigation areas outside the channel rights-of-way. Mitigation easements will also ensure that the normal dry weather flows of Potrero Creek through the Pete Kitchen mobile home park will be maintained. Table 25E. provides an estimate of the project related real estate costs.

J. RELOCATIONS

There would be no relocations of building structures for the project. The project would, however, require the permanent relocation of some utilities at various locations within project lands. One bridge replacement and the construction of a second bridge (both near Chula Vista) would be required. As a result of construction of these two bridges, some rerouting on the Old Tucson Highway would be Required, but traffic delays are not anticipated. The frontage road to U.S. Highway 89 would be used as a detour for through traffic. Local traffic would be rerouted with a temporary tie between Chula Vista and Pete Kitchen mobile home park.

K. CONSTRUCTION SCHEDULE

The construction of the lateral collector channels (LCC)s would require approximately six months to complete. This construction could occur any time throughout the year, however, there are two factors which should be considered. First, the majority of rains occur from July through October and second, visitor crossings at the International Boundary are typically greater in number from October through March.

The construction of the Chula Vista channels (CVC)s would require approximately nine months to complete. Engineeringly, the construction could occur any time throughout the year, however, there would be an advantage of avoiding the rain season. Cuttings would be taken from riparian trees that would be lost in the construction phase. These cuttings would then be planted along Potrero Creek to improve the habitat there as part of mitigation plan. This "dormant stub planting" is described in the EA, however, it is important to point out that this process has to be done in the dormant season (November through February).

L. ECONOMIC EVALUATION

The estimated first costs (of features included in the Recommended Plan) are provided in detail in Tables 25A. through 25E. A summary of these costs is provided in Table 25F. The "present value" of future repairs/replacements for the lateral collector channels (repairing invert of existing covered channels in 50 years) and the flood warning system (replacing system hardware every 20 years) is also included in this table. The total first cost of the Recommended Plan is \$6,022,600.

The economics of all project features are illustrated in Table 26. The overall benefit-cost ratio of the Recommended Plan is 2.2 to 1 (October 1986 price levels @ 8 7/8%) with total annual benefits of \$1,214,000 and total annual net benefits of \$652,850.

Interest during construction was included in the feature costs. Project benefits would accrue during the first and subsequent years of the projects life.

M. NATIONAL ECONOMIC DEVELOPMENT

National Economic Development (NED) is attained by project scaling so as to obtain maximum net benefits. This analysis is made by evaluating net benefits at various "levels of protection". The frequency where the greatest net benefits are attained is the NED plan. Project scaling for reach 2A and the lateral collector channel found the NED to be at the 33-year level of protection. The NED for reach 4-5 and the Chula Vista channels was found to be at the 100-year level of protection. This optimization of net benefits is illustrated in Figure 28. Scaling of the recreation plan and the flood warning system are not appropriate in terms of level of protection. Both of these features, however, are included in the NED Plan, as they do contribute to the maximization of benefits.

N. RECOMMENDED PLAN

The NED Plan is the Recommended Plan as it would produce the greatest net benefits and is fully supported by the local sponsor (Santa Cruz County Flood Control District).

Table 25A. Detailed Cost Estimate, 33 Yr. Lateral Collector Channels (October 1986 Price Levels)

Acct. No.	Description	Quantity	Unit	Unit Cost	Subtotal	Amount Total
NOGALES WASH LATERAL COLLECTOR CHANNELS						
FLOOD CONTROL						
Construction:						
09 Channel:						
	Diversion & control of water.....	1	Job	LS	\$8,100	
	Shoring.....	1	Job	LS	400	
	Excavation, channel & pipes.....	5,270	CY	3.55	18,709	
	Compacted fill.....	2,460	CY	3.20	7,872	
	Compaction of excess excavated material.....	2,380	CY	1.20	2,856	
	Concrete, invert.....	225	CY	94.00	21,150	
	Concrete, walls.....	326	CY	141.00	45,966	
	Concrete, roof.....	84	CY	176.00	14,784	
	Concrete, entry.....	21	CY	176.00	3,696	
	Portland cement.....	3,690	CWT	4.70	17,343	
	Steel reinforcement.....	78,600	Lbs	0.60	47,160	
	Reinforced-concrete pipe, 48-inch.....	59	LF	79.00	4,661	
	Reinforced-concrete pipe, 66-inch.....	104	LF	141.00	14,664	
	Reinforced-concrete pipe, 72-inch.....	591	LF	156.00	92,196	
	Asking 72-inch R.C.P. under railroad.....	1	Job	LS	35,200	
	Fencing, channel.....	520	LF	11.80	6,136	
	Steel gate.....	1,380	SF	8.20	11,316	
	Flap gate, 48-inch.....	1	Ea	5,870.00	5,870	
	Flap gate, 66-inch.....	2	Ea	13,400.00	26,800	
	Flap gate, 72-inch.....	4	Ea	16,000.00	64,000	
	Total channel.....				449,878	
	Contingent.....				112,122	
	Total channel.....					\$561,000
	Engineering & design.....					56,100
	Supervision & administration.....					55,900
	Total construction.....					673,000
Lands & relocations:						
	Lands & damages.....					\$0
	Relocations, roads.....	1	Job	LS	47,000	
	Total, lands & relocations.....					\$47,000
	Total, flood control.....					\$720,000

TABLE 25A-1. Detailed Cost Estimate; Repair of invert of
Existing Covered Channels (work to accomplish-
ed in approximately 50 years)

QUANTITY TAKE-OFF U.S. ARMY ENGINEER DISTRICT - LOS ANGELES				SHEET OF Feasibility ESTIMATE	
LOCATION & FY PROGRAM Nogales Wash & Tributaries, Arizona				JOB NO. Based on LA River Rehab. No Back-up	
DIRECTIVE JOB NO. Refurbishment of invert slab in Covered Channel		COMPUTED BY Steve Grubinski		PREPARED BY	
LINE ITEM NO.		CHECKED BY		DATE	
DESCRIPTION		DATE 2-4-86		DATE	
ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	Shotblasting & water wash debris of existing concrete surface & cover with mortar 1/8" to 1/4" Thick.	Limited access level, limited equipment	4000 ft long box culvert, high noise access.		
	Nogales Wash 4320' x 16' =	69,128	ft ²	3.00	207,384
	Arroyo Blvd Channel: 2200x23.1' + 1839.1 x 28' =	102,315	ft ²	3.00	306,945
	TOTAL	171,443	ft ²		
	Mortar Average 3/16" x 171,443 / 12x27	100	cy	60.00	6,000
	Portland Cement: 6.75 cwt/cy	675	cwt	5.00	3,375
	Placement of 4" new concrete slab (material & labor)				
	Nogales Wash 69,128 x .33 x 1.25 / 27 =	1056	cy	135.00	142,560
	Arroyo Blvd Channel 102,315 x .33 x 1.25 / 27 =	1563	cy	135.00	211,005
	TOTAL	2619	cy		
	Portland Cement 5.64 cwt / cy	14,772	cwt	5.00	73,860
	Diversion & Control of Water 16,800 lf curb 12" high (incl renewal)		Job	L.S.	100,800
	Contingency 25%				1,051,920 262,980
					1,314,911
		February 1986			\$1,315,000

END FORM
31 AUG 64 337

October 1986 cost	\$1,280,000
Present Value of \$1,280,000 (8 7/8% in 50 years)	\$18,200
October 1987 Cost	\$1,310,000
Present Value of \$1,280,000 (8 5/8% in 50 years)	\$20,900

TABLE 25B. Detailed Cost Estimate, 100yr. Chula Vista Channels
(October 1986 Price Levels)

Cost Acct No.	Description	Quantity	Unit	Unit Cost	Amount Subtotal	Total
CHULA VISTA CHANNEL (100-YR PLAN)						
FLOOD CONTROL						
Construction:						
09	Channel:					
	Diversions & control					
	of surface water...	1	Job	LS	\$54,000	
	Dewatering & ground-					
	water control.....	1	Job	LS	117,000	
	Clearing & grubbing..	1	Job	LS	3,890	
	Stripping.....	890	CY	\$7.10	6,319	
	Excavation, channel..	163,000	CY	3.25	529,750	
	Excavation, toe.....	5,200	CY	3.55	18,460	
	Excavation, R.C.P....	240	CY	4.70	1,128	
	Compacted fill, levee	5,100	CY	2.05	10,455	
	Compacted fill,					
	channel.....	15,100	CY	3.20	48,320	
	Compacted fill,					
	R.C.P.....	200	CY	2.35	470	
	Backfill, toe.....	4,300	CY	4.70	20,210	
	Miscellaneous fill,					
	compacted.....	5,380	CY	1.80	9,684	
	Stone.....	13,400	Ton	11.80	158,120	
	Grouting stonework...	2,800	CY	76.30	213,640	
	Inlet structure,					
	Potrero Creek.....	1	Job	LS	1,410	
	Outlet structure,					
	Potrero, Creek.....	1	Job	LS	4,770	
	Reinforced-concrete					
	pipe, 36-inch.....	250	LF	58.70	14,675	
	Concrete, center slab	1,550	CY	93.90	145,545	
	Concrete, footings...	1,490	CY	93.90	139,911	
	Concrete, walls.....	1,570	CY	141.00	221,370	
	Portland cement.....	45,800	CWT	4.70	215,260	
	Steel reinforcement..	491,000	Lb	0.50	245,500	
	Transitions.....	1	Job	LS	152,000	
	Invert access ramp...	1	Job	LS	4,210	
	Aggregate base.....	530	CY	30.60	16,218	
	Asphaltic concrete					
	paving.....	540	Ton	70.50	38,070	
	Fencing, channel.....	2,860	LF	11.80	33,748	
	Steel pipe gates,					
	single-drive.....	7	Ea	5,280.00	36,960	
	Subdrainage system...	1	Job	LS	\$187,000	
	Esthetic treatment...	1	Job	LS	54,900	
	Mitigation measures..	1	Job	LS	54,500*	
	Subtotal, channel.....				2,757,493	
	Contingencies.....				682,507	
	Total, channel.....					\$3,440,000
30	Engineering & design.....					340,560
31	Supervision & administration.....					339,440
	Total, construction.....					4,120,000
Lands & relocations:						
	Lands & damages.....					183,000 **
	Relocations:					
	Utilities:					
	Water.....	1	Job	LS	16,600	
	Sewer.....	1	Job	LS	43,000	
	Gas.....	1	Job	LS	7,800	
	Power.....	1	Job	LS	3,500	
	Telephone.....	1	Job	LS	3,100	
	Total utilities.....				74,000	
	Bridges.....	1	Job	LS	763,000	
	Total, relocations.....					837,000
	Total, lands & relocations.....					1,020,000
	Total, flood control.....					5,140,000

* Habitat improvement and fencing

** See Table 25E for further breakdown

Table 25C. Detailed Cost Estimate - Flood Warning System
(October 1985 Price Levels @ 8 5/8%)

	<u>First Cost of Construction</u>	<u>Replacement Cost</u>
7 Self Reporting Rain Gages	\$ 18,200	\$ 18,200
3 Self Reporting Stream Gages	\$ 3,000	\$ 3,000
3 S.R.S.G. with Siren & Associated Equipment	\$ 3,700	\$ 3,700
1 Repeaters & Associated Equip.	\$ 5,000	\$ 5,000
1 Receiving Antenna (w/cables)	\$ 100	\$ 100
1 Microcomputer	\$ 4,100	\$ 4,100
1 Audible Alarm Device	\$ 200	\$ 200
1 Printer for Microcomputer	\$ 2,100	\$ 2,100
1 Auto-answer Modem for Micro- computer - Telephone Interface	\$ 300	\$ 300
1 Remote-Station-Testing Equipment Package	\$ 3,000	\$ 3,000
1 Spare Electronics Package for Gages	\$ 2,800	\$ 2,800
1 Microcomputer Software Package	\$ 0	\$ 0
Subtotal	\$ 42,500	\$ 42,500
Labor	\$ 29,600	\$ 29,600
Subtotal	\$ 72,100	\$ 72,100
Contingency (25%)	\$ 18,000	\$ 18,000
Engineering & Design (10%)	\$ 7,200	\$ 7,200
Supervision & Admin. (10%)	\$ 7,200	\$ 7,200
TOTAL	\$104,500	\$ 104,500
Updated to Oct 1986 Price Levels @ 8 7/8%	\$107,000	\$ 107,000

Table 25D. Detailed Cost Estimate, Recreation Plan
(October 1986 Price Levels)

Descr.	Estimate Quant.	Unit	Unit Cost	Total Cost
Picnic Table	3	Ea.	\$1,100	\$3,300
Shelters	3	Ea.	3,000	9,000
Slab	702	SFt	1.90	1,334
Grill	3	Ea.	650	1,950
Signs	6	Ea.	100	600
T.Recpt.	3	Ea.	500	1,500
Subtotal				17,700
E&D and S&A				1,770
Contingency				3,530
Recreation Development Subtotal.....				23,000

Table 25E. Detailed Cost Estimate - Lands, Easements, and Rights-of-Way
(October 1986 Price Levels @ 8 7/8%)

	Area Required (Acres)	Estimated Value
Construction Lands	11.55	\$107,895
Mitigation Lands	8.27	8,270
Severance Damage	N/A	67,000
TOTAL	19.82	\$183,165
Average Land Value:	(\$183,165 / 19.82) \$ 9,241	
Maximum Land Value:	\$20,000	
Minimum Land Value:	\$ 1,000	

Table 25F. Summary of Feature First Costs, Recommended Plan
(October 1986 Price Levels)

Description	Nonales Wash Lateral Collector Channels (33-Year Plan)	Chula Vista Channels (100-Year plan)	Flood Warning System	Recreation Plan	TOTAL PLAN
Construction/Installation:					
Feature First Cost	\$561,000	\$3,440,000	\$92,500	\$21,000	\$4,114,500
Engineering and Design	56,000	340,560	7,400	1,000	405,060
Supervision and Administration	55,900	339,440	7,400	1,000	403,740
Total, Construction	673,000	4,120,000	107,300	23,000	4,923,300
Lands and Relocations:					
Lands and Damages	0	193,000	0	0	193,000
Relocations:					
Utilities	0	74,000			74,000
Bridges	47,000	263,000			310,000
Total, Relocations	47,000	337,000			384,000
Total, Lands & Relocations	47,000	530,000			577,000
Future Repairs/Replacement	18,200 *	0	34,100 **	0	52,300
Total, Feature First Cost	\$738,200	\$5,140,000	\$141,400	\$23,000	\$6,042,600

* Present Value of \$1,315,000 for repair to invert of existing covered channels (to be accomplished in approximately 50 years).

** Present Value of \$63,200 for replacing system hardware every 20 years.

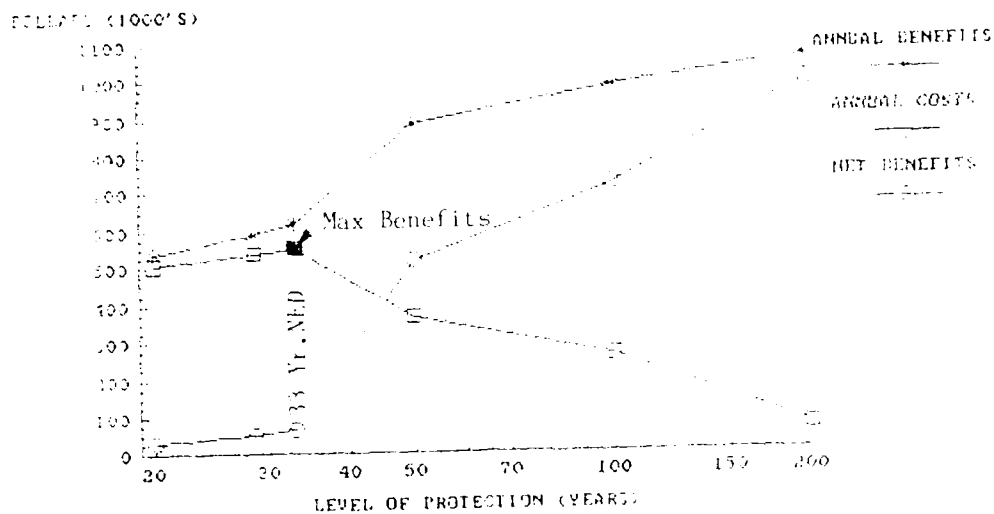
Table 25G. Chula Vista Channels - Individual Ownership of Areas Receiving Location Benefits
(October 1986 Price Levels @ 8 7/8%)

Owner	1	2	3	4	5	6	7	TOTAL
Acres	16.8	11.4	21.2	1.6	10.0	1.1	1.7	64.8
								Area owned by 7 individuals listed.

Table 26. Economic Justification, Recommended Plan
(October 1986 Price Levels)

	Nogales Wash Lateral Collector Channels (35-Year Plan)	Chula Vista Channels (100-Year Plan)	Flood Warning System	Recreation Plan	TOTAL PLAN
BENEFIT CATEGORIES					
Inundation Reduction	\$595,000	\$398,000			
Savings in Emergency Cost	1,000	13,000			
Savings in Utility/RR/Cost	12,000	4,000			
Freeboard		87,000			
Location		17,000			
Advanced Replacement-Bridges	6,000	44,000		9,000	
Employment					
Recreation					
TOTAL ANNUAL BENEFITS	\$618,000	\$563,000	\$24,750	\$9,000	\$1,214,750
COST CATEGORIES					
Feature First Cost (including present value of future repairs/replacement)	738,200	5,140,000	121,400	23,000	6,022,600
Interest During Construction	15,400	167,000	2,200	0	184,600
TOTAL COST	753,600	5,307,000	123,600	23,000	6,207,200
Annualized Cost (100 years @ 8 7/8%)	66,900	471,000	11,000	2,000	550,900
Annual Operation/Maint./Repair	1,000	7,000	1,000	2,000	11,000
TOTAL ANNUAL COST	\$67,900	\$478,000	\$12,000	\$4,000	\$561,900
ECONOMIC JUSTIFICATION					
Benefit-Cost Ratio	9.1	1.2	2.1	2.3	2.2
Net Benefits	\$550,000	\$ 85,000	\$12,750	\$5,000	\$652,850

BORDER AREA ANNUAL BENEFITS VERSUS ANNUAL COSTS
NOGALES WASH ECONOMIC ANALYSIS



CHULA VISTA ANNUAL BENEFITS VERSUS ANNUAL COSTS
NOGALES WASH ECONOMIC ANALYSIS

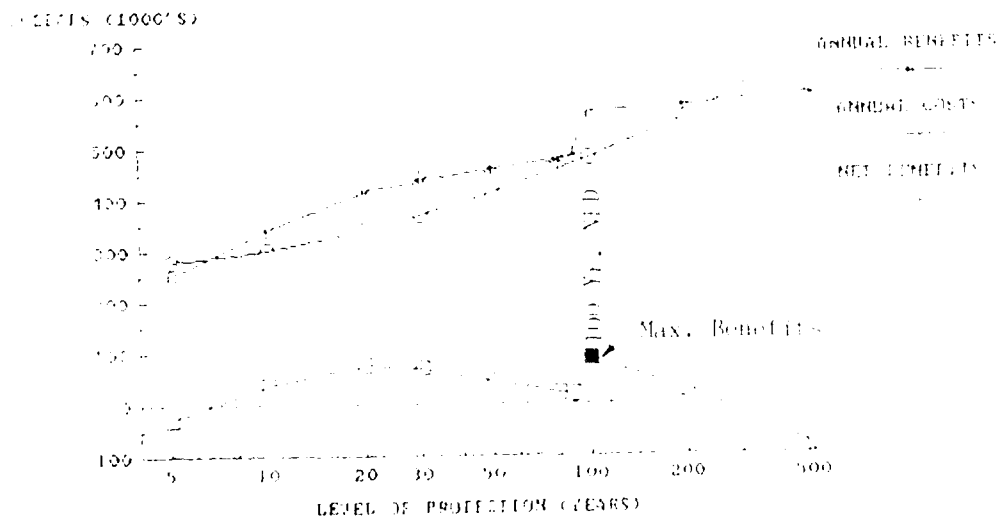


Figure 28
LATERAL COLLECTOR AND
CHULA VISTA CHANNELS
Annual Cost, Benefit, and
Net Benefit Curve

CHAPTER VI PLAN IMPLEMENTATION

This chapter summarized the cost-sharing requirements and procedures necessary to implement the flood control and recreation features of the recommended plan.

A. DIVISION OF PLAN RESPONSIBILITIES

The Water Resources Development Act (WRDA) of 1986 (P.L. 99-662) and various administrative policies have established the basis for the division of Federal and non-Federal responsibilities in the construction, maintenance, and operation of Federal water resource projects accomplished under the direction of the Corps of Engineers.

1. Allocation of Costs

The majority of the project costs (approximately 99.7%) are for flood control purposes. The remaining 0.3% are for associated recreation purposes.

2. Cost Apportionment

For flood control purposes, the WRDA of 1986 provides that the Local Sponsor (Santa Cruz) County Flood Control District) shall pay in cash, 5% of the cost of the structural portion of the flood control project during the construction phase; provide all lands, easements, rights-of-way and dredged material disposal areas; provide relocations of bridges and roadways; provide alterations of utilities which do not pass under or through the project's structure; maintain and operate the project after construction; and assume the administration, operation and maintenance responsibilities of the environmental mitigation measures. Also, during the construction phase, the local sponsor shall contribute in cash any additional funds as are necessary so that the local contribution would be a minimum of 25% of those costs assigned to structural flood control measures (the lateral collector channels and the Chula Vista channels), and a minimum of 50% of those costs assigned to recreation. For non-structural flood control measures (the flood warning system), a minimum 25% local contribution shall also be applied, however, the local sponsor has the option of paying its share, plus interest, over a 15-year period after construction.

TABLE 27. Feature, Land, Relocation Cost; Recommended Plan
(October 1986 Price Levels @ 8/7/82)

	Lateral Collector Channel	Chula Vista Channels	Flood Warning System	Recreation	Total
Construction Cost (including present value of future repairs/ replacement)	\$ 691.2	\$4120.0	\$ 121.4	\$ 23.0	\$4955.6
Relocations					
Roadway & Bridge	47.0	763.0			810.0
Utilities which do not pass und. or thru the project's structure		6.6			6.6
Utilities which pass under or thru the project's structure		67.4			67.4
<u>Lands, Easements, & Rights-of-way</u>		<u>183.0</u>			<u>183.0</u>
Total First Cost	738.2	5140.0	121.4	23.0	6022.6

**TABLE 28. Cost Apportionment, Recommended Plan
(\$1000, October 1986 Price levels
@ 8 7/8%)**

	First Cost	Federal Share	Non-Federal Share
LATERAL COLLECTION CHANNELS			
1. Construction (less future repairs/replacement)	\$ 671.0	\$ 671.0	\$ 0
2. Construction Lands, Easements, and Rights-of-way	0	0	0
3. Relocations			
a. Roadway	47.0	0	47.0
b. Utility	0	0	0
4. Mitigation Measures	0	0	0
5. Present Value of Future Repairs/Replacements	18.2	18.2	0
6. Subtotal	736.2	699.2	47.0
7. Initial 5% Cash Contribution Paid by Sponsor During Construction Phase		- 36.9	+ 36.9
8. Subtotal		662.3	83.9
9. Additional Cash to be Paid by Sponsor to Provide a Min. 25% of Total First Cost (line 6)		-100.7	+100.7
10. Total		\$ 561.6	\$ 184.6
CHULA VISTA CHANNELS			
11. Construction (less mitigation)	\$4765.5	\$4765.5	\$ 0
12. Construction Lands, Easements, and Rights-of-way (less mitigation)	174.7	0	174.7
3. Relocations			
a. Roadway & Bridge	763.0	0	763.0
b. At and Above Grade Utilities	6.6	0	6.6
c. Below Grade Utilities	67.4	67.4	0

Footnotes:

* To be paid during construction phase

** May be paid over 15 years period after construction, however, sponsor would be required to pay interest.

Continued

14. Mitigation Measures			
a. Construction	54.5	54.5	0
b. Lands, Easements, and Rights-of-way	8.3	0	8.3
15. Subtotal	5140.0	4187.4	952.6
16. Initial Cash Contribution Paid by Sponsor During Construction Phase		-257.0	+257.0
17. Subtotal		3930.4	1209.6
18. Additional Cash to be Paid by Sponsor to Provide a Min. 25% of Total First Cost (line 15)		-74.5	+74.5
19. Total		\$3855.0	\$1285.0
NON-STRUCTURAL FLOOD CONTROL			
20. Construction	\$ 107.3	\$ 107.3	\$ 0
21. Lands, Easements and Rights-of-way	0	0	0
22. Present Value of Future Repairs/Replacements	14.1	14.1	0
23. Subtotal	121.4	121.4	0
24. Additional Cash to be Paid by Sponsor to Provide a Min. 25% of Total First Cost (line 23) **		-30.4	+30.3 *
25. Total		\$ 91.1	\$ 30.3
RECREATION			
26. Construction	\$ 23.0	\$ 23.0	\$ 0
27. Lands, Easements, and Rights-of-way	0	0	0
28. Subtotal	23.0	23.0	0
29. Additional Cash to be Paid by Sponsor to Provide a Min. 10% of Total First Cost (line 28) *		-11.5	+11.5 *
30. Total		\$ 11.5	\$ 11.5
31. Grand Total	\$46022.6	\$4511.2	\$1511.4

Table 27 illustrates the feature costs and costs associated with lands and relocations; and Table 28 illustrates the apportionment of first costs between Federal and non-Federal interests for the recommended plan.

3. Federal Responsibilities

The presently estimated Federal share of the total first cost of the project is \$4,511,200. In addition to its financial responsibility, the Federal Government would:

- a. design and prepare detailed plans and specification,
- b. administer contracts for construction and supervision of the project after authorization, funding, and receipt of non-Federal assurances,
- c. conduct all necessary cultural resource investigations and coordinate and implement any necessary preservation or mitigation measures, and
- d. conduct periodic inspections with the non-Federal sponsor to determine adherence to the post-construction maintenance requirements.
- e. install, maintain, repair and replace the flood warning system components in Mexico with non-Federal payment for these costs.

4. Non-Federal Responsibilities

The presently estimated non-Federal share of the total first cost of the project is \$1,511,400. In addition, maintenance and operation of the project would cost local interests \$11,000 annually. The local sponsor for the project is the Santa Cruz County Flood Control District. Requirements of local cooperation are specified below:

- a. Provide certain lands, easements (to include an O&M easement for the Chula Vista low flow channel), rights-of-way, excess fill disposal areas for construction of structural flood control measures (\$174,700), for mitigation measures (\$8,300), for non-structural flood control measures in the United States (\$0), and for recreation measures (\$0) presently estimated at a total of \$183,000.
- b. Accomplish all bridge and roadway alterations (\$810,000), and relocation of utilities which do not pass under or through the project's structure (\$6,600), presently estimated at \$816,600.
- c. Pay 5% of the cost of the project assigned to structural flood control (\$293,900), plus additional cash during construction (\$176,100) to provide a minimum 25% local contribution to that purpose, presently estimated at \$470,000.
- d. Pay additional funds during the construction phase to provide a 50% local contribution for recreation measures (\$11,500), presently estimated are \$11,500.
- e. Pay during the construction phase (\$30,300), or pay after the construction phase (\$30,300 + interest), to provide a minimum 25% local

contribution for non-structural flood control measures, presently estimated at \$30,300.

f. Maintain and operate project facilities in the United States after completion in accordance with regulation to be prescribed by the Secretary of the Army at an annual cost presently estimated at \$11,000.

g. Provide the federal government funds for the cost of maintaining flood warning components in Mexico (cost of this is included in item f. above).

h. Hold and save the United States free from damages due to construction, operation, and maintenance of the project, excluding damages due to the fault or negligence of the United States or its contractors, and free from water rights claims caused by construction and operation of the project.

i. Prescribe and enforce regulations to prevent obstruction or encroachment on flood control works that would reduce their flood-carrying capacity or hinder maintenance and operation.

j. Comply with the applicable requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

k. Comply with Section 221 of the Flood Control Act of 1970.

l. Publicize flood plain information in the areas where structural measures were not found justified and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise development in the flood plain.

B. SPONSORSHIP AGREEMENTS

The Santa Cruz County Flood Control District has provided a Letter of Intent assuring acknowledgement of sponsorship requirements for the Nogales Wash Flood Control Project (see page 6-6). Prior to the start of construction, the local sponsor will be required to enter into an agreement with the Federal Government that it will comply with Section 221 of the Flood Control Act of 1970 (P.L. 91-611) and the Water Resources Development Act of 1986 (P.L. 99-662).

C. PROCEDURES FOR IMPLEMENTATION

Future actions necessary for authorization and construction of the recommended plan are summarized as follows:

1. This report will be reviewed within the Corps of Engineers, including the Board of Engineers for Rivers and Harbors and the Office of the Chief of Engineers in Washington, D.C.

2. The Chief of Engineers will seek formal review and comment by the Governor of the State of Arizona and interested Federal Agencies.

3. Following the State and Agency review, the report of the Chief of Engineers will be sent to the Assistant Secretary of the Army for Civil Works.

4. Upon approval of the Assistant Secretary, the report will be forwarded to the Office of Management and Budget (OMB) to obtain the relationship of the project to programs of the President.

5. The final report of the Chief of Engineers will then be forwarded by the Assistant Secretary of the Army for Civil Works to Congress.

6. Congressional review of the feasibility report and possible authorization of the project would follow.

7. Pending project authorization for construction, the Chief of Engineers could include funds when appropriate, in his budget requests for continuing planning and engineering of the project. The objective is to ready each project for a construction start established with the feasibility study.

8. Following receipt of funds, continuing planning and engineering studies would be initiated and surveys and detailed engineering designs would be accomplished.

9. Following Congress authorization of the project, plans and specifications would be accomplished by the District Engineer.

10. Subsequent to appropriation of construction funds by Congress, but prior to construction, formal assurances of local cooperation would be required from non-Federal interests.

11. Bids for construction would be initiated and contracts awarded.

Camilo Ahumada
District 1
Nogales

Cesar N. Parada, Sr.
District 2
Nogales

Ronald R. Morris
District 3
Patagonia

BOARD OF SUPERVISORS
SANTA CRUZ COUNTY

F. DeCillis
Clerk

P. O. BOX 1150
NOGALES, ARIZONA 85628
PHONE 287-4778

August 25, 1987

Colonel Tadahiko Ono
District Engineer
Corps of Engineers
Los Angeles District
P.O. Box 2711
Los Angeles, CA 90053

Dear Colonel Ono:

The Santa Cruz County Flood Control District has reviewed the Draft Feasibility Report and Environmental Assessment for Nogales Wash and Tributaries, Nogales, Arizona. The Flood Control District supports the recommended plan for the "lateral collector channel" at the International Boundary, the "Chula Vista channel" and associated recreation component, and the flood warning system. This plan would provide 33-year flood protection for the downtown community from the International Boundary to the existing covered channel outlets, 100-year flood protection for the Chula Vista - Pete Kitchen community, and advanced flood warning for much of the developed areas of the Nogales Wash-Potrero Creek watershed. This plan would provide relief from a most pressing flood problem. The Corps worked very closely with the County Board of Supervisors, the Flood Control District and other County and City of Nogales officers. This close coordination resulted in the formulation and development of a rational solution acceptable to the community.

By means of this Letter of Intent, we want to assure you of our intent to participate in this flood control project. We understand that Santa Cruz County shall provide, during the period of construction, a cash contribution of 5 percent of the total flood costs. If the value of lands, easements, rights-of-way, relocations and the 5 percent contribution represents less than 25 percent of total flood control costs, the Department shall provide, during the period of construction, an additional cash contribution in the amount necessary to make its total contribution equal to 25 percent of the total flood control costs. We also understand the specific requirements of local participation:

- 1 To provide all lands, easements, and rights-of-way and all alterations and relocations of utilities, streets, highways, bridges, buildings, storm drains, and other structures and improvements.

2 To provide a cash or in-kind construction or land contribution towards reasonable fish and wildlife mitigation features in an amount equal to the same percentage as the non-federal share of flood control costs as required by the then current rules and regulations.

3 To hold and save the United States free from water rights claims caused by construction and operation of the project.

4 To prescribe and enforce regulations to prevent obstruction or encroachment of flood control works that would reduce their floodcarrying capacity or hinder maintenance and operation.

5 Comply with applicable requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

6 Comply with Section 221 of the Flood Control Act of 1970.

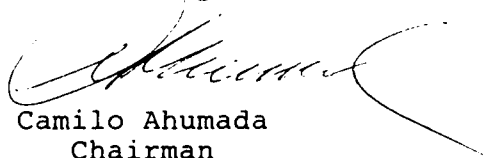
7 Assume operation and maintenance of the works after completion in accordance with regulations prescribed by the Secretary of the Army.

It is expected that there will be substantial consulting with the Flood Control District staff on mitigation measures as project design progresses. In transmitting this Letter of Intent, it is mutually understood that the local financial responsibility will not be committed until Congress appropriates funds for construction of the projects.

Residents, business, and government agencies face a serious international flood threat on a yearly basis. The Flood Control District and its Board of Directors are anxious to relieve the Community of this ongoing problem and will cooperate in any way to see the Corps' plan for Nogales Wash implemented.

We wish to take this opportunity to thank you and your staff for your efforts in assisting Santa Cruz County in solving our flood related problems.

Sincerely,



Camilo Ahumada
Chairman
Board of Supervisors
Santa Cruz County

CA:fe

Cumilo Ahumada
District 1
Nogales

Cesar N. Parada, Sr.
District 2
Nogales

Ronald R. Morriss
District 3
Panguitch

BOARD OF SUPERVISORS
SANTA CRUZ COUNTY

F. De Cillis
Clerk

P.O. BOX 1150
NOGALES, ARIZONA 85628
PHONE 287-4778

May 26, 1988

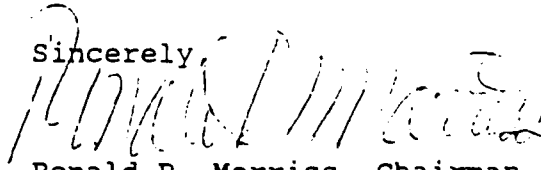
Colonel Tadahiko Ono
District Engineer
Army Corps of Engineers
300 North Los Angeles St.
Los Angeles, California 90012

Dear Colonel Ono:

The Santa Cruz County Board of Supervisors, serving as the governing board of the County Flood Plain & Flood Control District, has reviewed the "Draft Feasibility Report and Environmental Assessment, Nogales Wash & Tributaries, Nogales, Arizona" dated August 1987. The Board of Supervisors, and the Director of Planning & Zoning, also participated in a Corps of Engineers Conference in Washington, D. C. in October 1987, at which time final changes to the "Recommended Plan" were discussed. The Board of Supervisors and the county as a whole fully support the recommended plan for the lateral collector channels, the Chula Vista channels, the small recreation component associated with the Chula Vista channels, and the flood warning system. This plan would solve a most pressing flood problem.

By means of this letter, we want to assure you of our intent to participate in, and support, the implementation of this plan. The Corps worked very closely with the local community in formulating and developing this plan. We commend your staff for its outstanding efforts and look forward to continuing this fine relationship in the ongoing process.

Sincerely,


Ronald R. Morriss, Chairman

cc: Paul Blakey



OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO
THE COMMONS, BUILDING C, SUITE 310
4171 NORTH MESA
EL PASO, TEXAS 79902

MAY 26 1988

Colonel Tadahiko Ono
Corps of Engineers, Los Angeles District
300 North Los Angeles Street
Los Angeles, California 90012

Dear Colonel Ono:

Upon review of the Draft Feasibility Report, Nogales Wash and Tributaries Study dated August 1987, and after the May 12, 1988 meeting with you and your staff, the U.S. Section of the International Boundary and Water Commission fully supports the Corps recommended plan. Your report has accurately identified the flooding problems in the Nogales, Arizona and Nogales, Sonora area and the solutions which you have selected should significantly reduce these problems in the United States.

We are especially interested in the relationship of the proposed Lateral Collector Channels to the International Boundary and the proposed Flood Warning System to Mexico. I will discuss the Flood Warning System proposed for installation in Mexico with the Mexican Commissioner.

I commend you and your staff for its effectiveness in working with the City, County, State, and other Federal agencies in formulating and developing the conceptual plan for the project. Your District's coordination with this office has been outstanding. We look forward to continuing this excellent working relationship during the upcoming phases of the project.

Sincerely yours,


Narendra N. Gunaji
Commissioner

cc: Paul Blakey, Phoenix

SEP 7 1988

CHAPTER VII

DISCUSSION

The District Engineer, Los Angeles District, U. S. Army Corps of Engineers, has reviewed and evaluated, in light of overall public interest, the data, information, and alternatives for water resources development pertaining to the Nogales, Arizona area. The principle elements considered in the review included engineering feasibility, environmental impacts and effects, economic factors of regional and national economic development, and social well-being, all of which have been evaluated in light of the purposes of the proposed improvements. The data and information reviewed include investigations and studies prepared by Los Angeles District staff, documents and information furnished by local interests, and the stated views of these interests and agencies relative to the various practical alternatives for achieving stated objectives of providing flood control and related water resource features along the Nogales Wash/Potrero Creek mainstem.

This Nogales Wash Feasibility Study Report constitutes compliance with the overall Gila River and Tributaries, Arizona and New Mexico study authority. It identifies historic and recent significant damages from flooding as well as projecting future damages. It has identified flood inundation as serious water resources problem within the study area.

Alternative plans for solving flood problems within the study area were formulated and evaluated to determine the relative consequences of each. The plans considered in this report have been coordinated with interested agencies at the Federal, state and local levels. Several public meetings and informational meetings with local officials were held by the local sponsor to solicit public input and preferences used in formulating the alternative plans and in selecting the plan to be recommended. Environmental impacts associated with the selected plan are not deemed to be significant. The selected plan would reduce future flood and erosion damage in the study area as well as reduce the risk to human life and safety. The impacts of the Recommended Plan would not significantly increase flood damages in downstream areas. It is also the plan favored by the non-Federal sponsor, Santa Cruz County.

From an economic standpoint, the Recommended Plan would significantly reduce financial losses, both public and private. This would include losses to businesses and wage earners caused by flood related interruptions, and the costs of flood fighting and clean-up.

The District Engineer has recognized that the Nogales vicinity is sensitive to its environmental (riparian habitat) amenities. He believes that concerns for these amenities have been satisfied by the Recommended Plan, with a combination of mitigation and aesthetic treatment. The District Engineer concurs with the recommendations within the attached Environmental Assessment, and has personally inspected the project area.

The relationship of the Recommended Plan to the United States/Mexico International Boundary was found to be sensitive in several respects. The possible consequences of providing a lateral collector channel on the United States side of the International Boundary and installing components of a flood warning system in Mexico, were studied and evaluated for social, political, and economic effects; engineering legal statutes; environmental impacts; and appropriateness for meeting the stated objectives of the investigation and implementability. It is normally the responsibility of the non-Federal sponsor to provide lands, easements, and rights-of-way and to provide operation, maintenance, and repair for all project facilities. However, due to the unique relationship of the flood warning system to Mexico (five rain or stream gages are located in Mexico), it was determined that the Federal Government should take responsibility for these items. This determination is based upon the assumed position that the Federal Government (the Corps in coordination within the International Boundary and Water Commission) would have a greater opportunity and success in providing system requirements in Mexico. The non-Federal sponsor would provide the Federal Government funds for the cost of maintenance, repair, and replacement of these components. The proposed actions of the Recommended Plan will require continued coordination, through the International Boundary and Water Commission (IBWC), with the national, state, and local governments within Mexico.

The selected plan of improvement for the Nogales Wash Study Area, as developed in this report, is based upon a thorough analysis and evaluation of various practical alternatives for achieving the stated objectives; that no significant adverse effects were found; that the recommended plan is consonant with national policy and administrative directives; and that, on balancing all elements, the total public interest would best be served by the construction of the recommended plan.

CHAPTER VIII RECOMMENDATIONS

I recommend that the plan described herein for flood control be authorized for implementation as a Federal project, with such modifications as in the discretion of the Chief of Engineers may be advisable, and subject to cost sharing and financing arrangements satisfactory to the President and the Congress. The project would include the construction of flood protection works, a flood warning system, and recreation development. The total first cost of the project at October 1987 price levels and an 8 5/8% amortization rate is estimated at \$6,162,600; the Federal share is \$4,616,100; the non-Federal share is \$1,546,500 of which \$1,359,200 is cash and \$187,300 is for lands, easements, and rights-of-way (at October 1986 price levels and 8 7/8% amortization, these figures are respectively \$6,022,600; \$4,511,200; \$1,511,400 of which \$1,328,400 is cash and \$183,000 is for lands, easements, and rights-of-way). The Corps of Engineers, in coordination with the International Boundary and Water Commission, would acquire any easements or rights-of-way for, and install, maintain, repair and replace the flood warning system in Mexico. This recommendation is made with the provision that prior to implementation, non-Federal interests will, in accordance with the requirements of the Water Resources Development Act of 1986 (PL 99-662), agree to comply with the following:

1. Provide certain lands, easements (to include an O&M easement for the Chula Vista low flow channel), rights-of-way, excess fill disposal areas for construction of structural flood control measures, mitigation measures, non-structural flood control measures, and recreation measures.
2. Accomplish, without cost to the United States, all alterations and relocations or removal of buildings, transportation facilities, storm drains, sewers, utilities, and other structures and improvements made necessary by the construction of the project (other than those utilities which pass under or through the project's structure and excluding railroad bridges and approaches thereto), and facilities necessary for the normal interception and disposal of local interior drainage at the line of protection.
3. Pay 5% of the cost of the project assigned to structural flood control.
4. If the value of the contributions provided by the non-Federal interest are less than 25 percent of the first cost of construction of the flood control and flood warning facilities, the non-Federal interest shall pay during construction such additional cash so that their total contribution is equal to 25 percent of the above stated cost.
5. Pay additional funds during the construction phase to provide a 50 percent local contribution for recreation measures.
- 6a. Maintain and operate project facilities in the United States after completion in accordance with regulations to be prescribed by the Secretary of the Army at an annual cost presently estimated at \$11,000.
- 6b. Pay the Federal Government for its cost in obtaining any easements or rights-of-way for and maintaining the flood warning system components in Mexico (cost of this is included in item f. above).

7. Hold and save the United States free from damages due to construction, operation, maintenance of the project, excluding damages due to the fault or negligence of the United States or its contractors, and free from water rights claims caused by construction and operation of the project.

8. Prior to installation or construction, prescribe and enforce regulations to prevent obstruction or encroachment on flood control works that would reduce their flood-carrying capacity or hinder maintenance and operation.

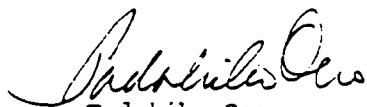
9. Comply with the applicable requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

10. Comply with Section 221 of the Flood Control Act of 1970.

11. Publicize flood plain information in the areas where structural measures were not found justified and provide this information to zoning and other regulatory agencies for their guidance and leadership on preventing unwise development in the flood plains.


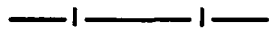


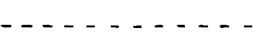
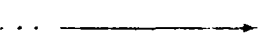

12. Assure access to the recreation facilities to all on equal terms.

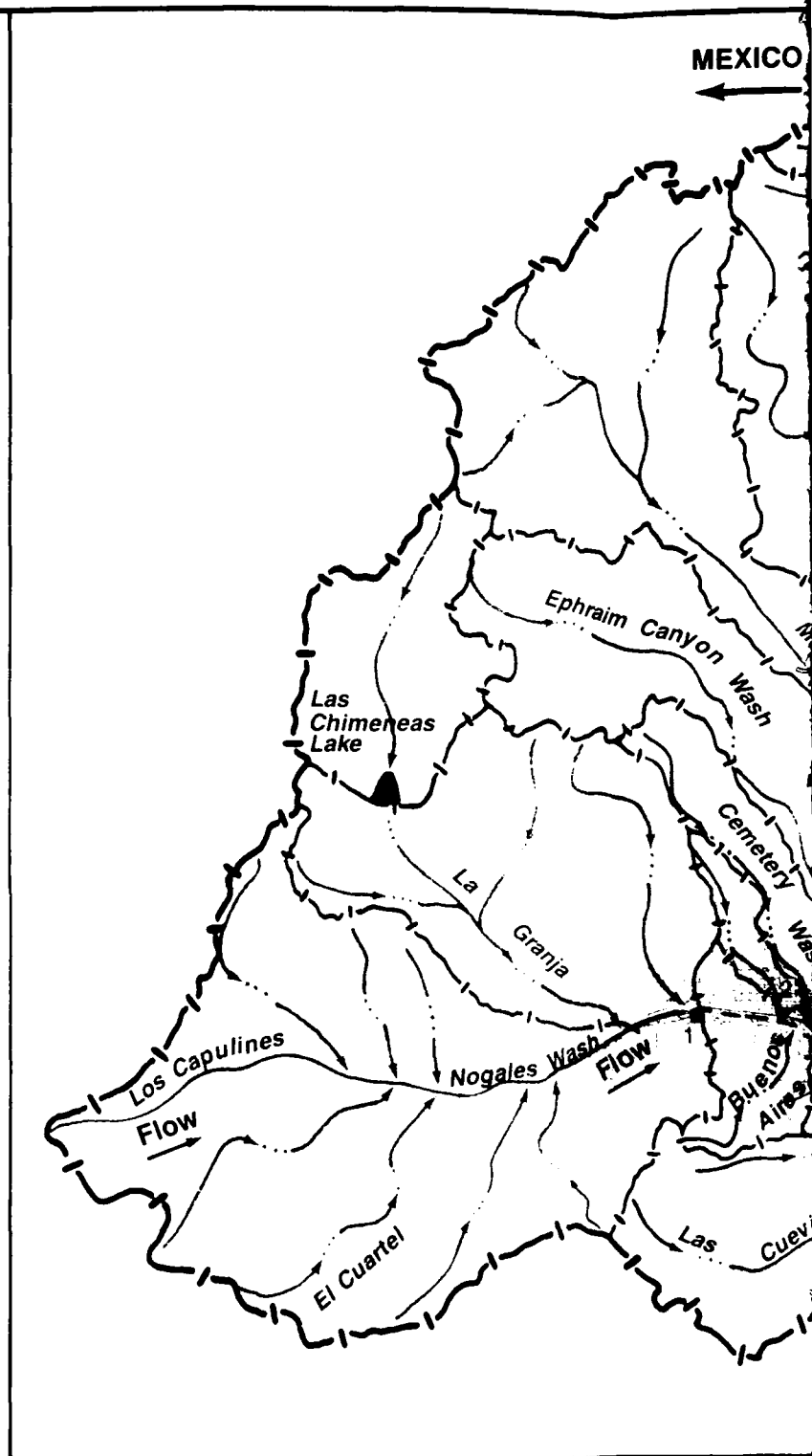
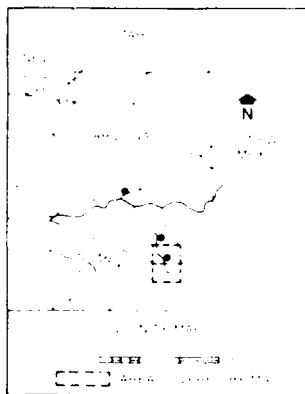
The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect budgeting and programming priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendation may be modified before they are transmitted to the Congress as proposals for authorized and/or implementation funding.

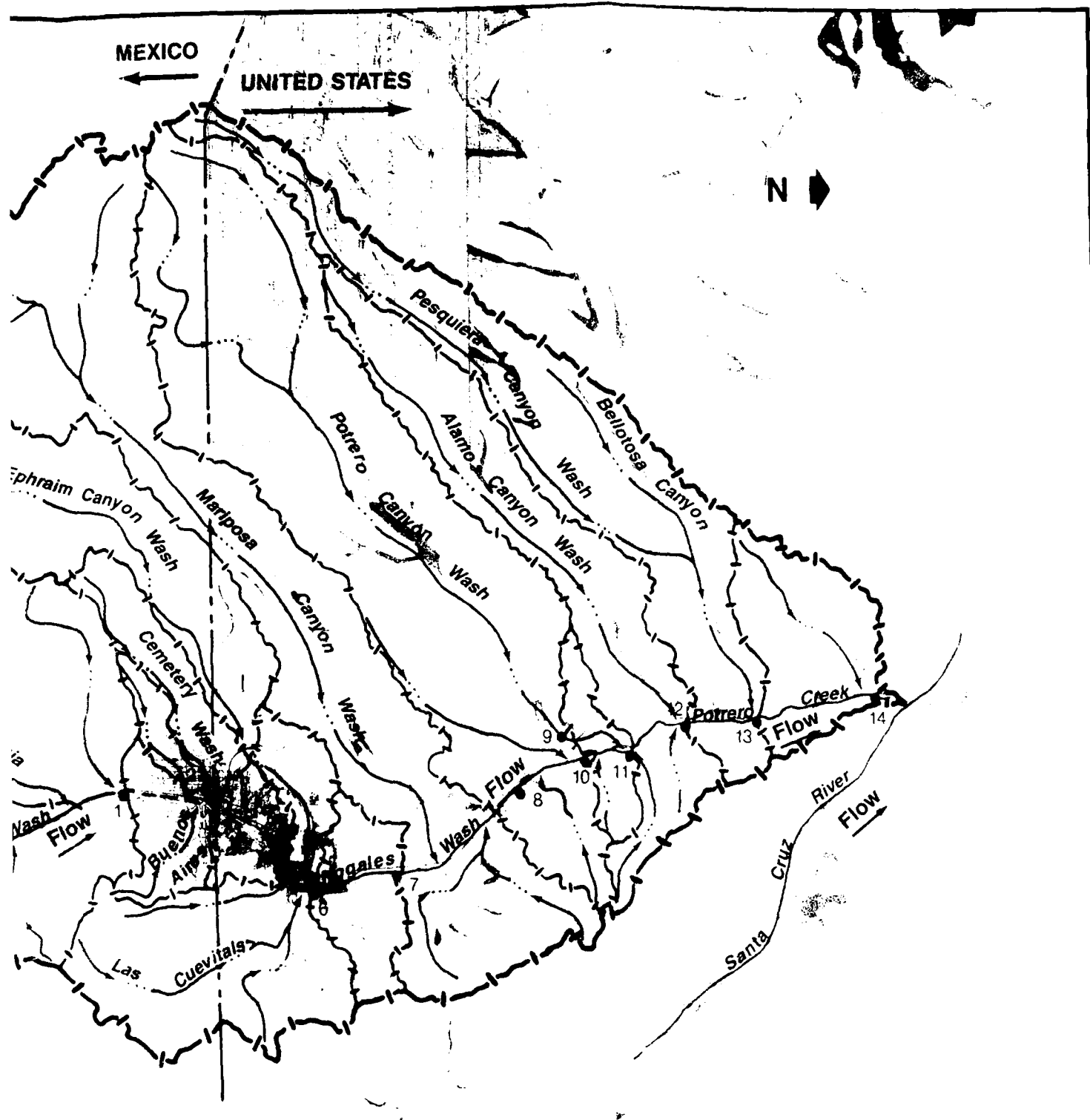


Tadahiko Ono
Colonel, Corps of Engineers
District Engineer

LEGEND

-  Nogales Wash/Potrero Creek Drainage Area
-  Subarea Boundaries
-  International Boundary
-  Nogales Wash/Potrero Creek Mainstem
-  Covered Floodway
-  Tributaries to Mainstem
-  # Hydrologic Concentration Point



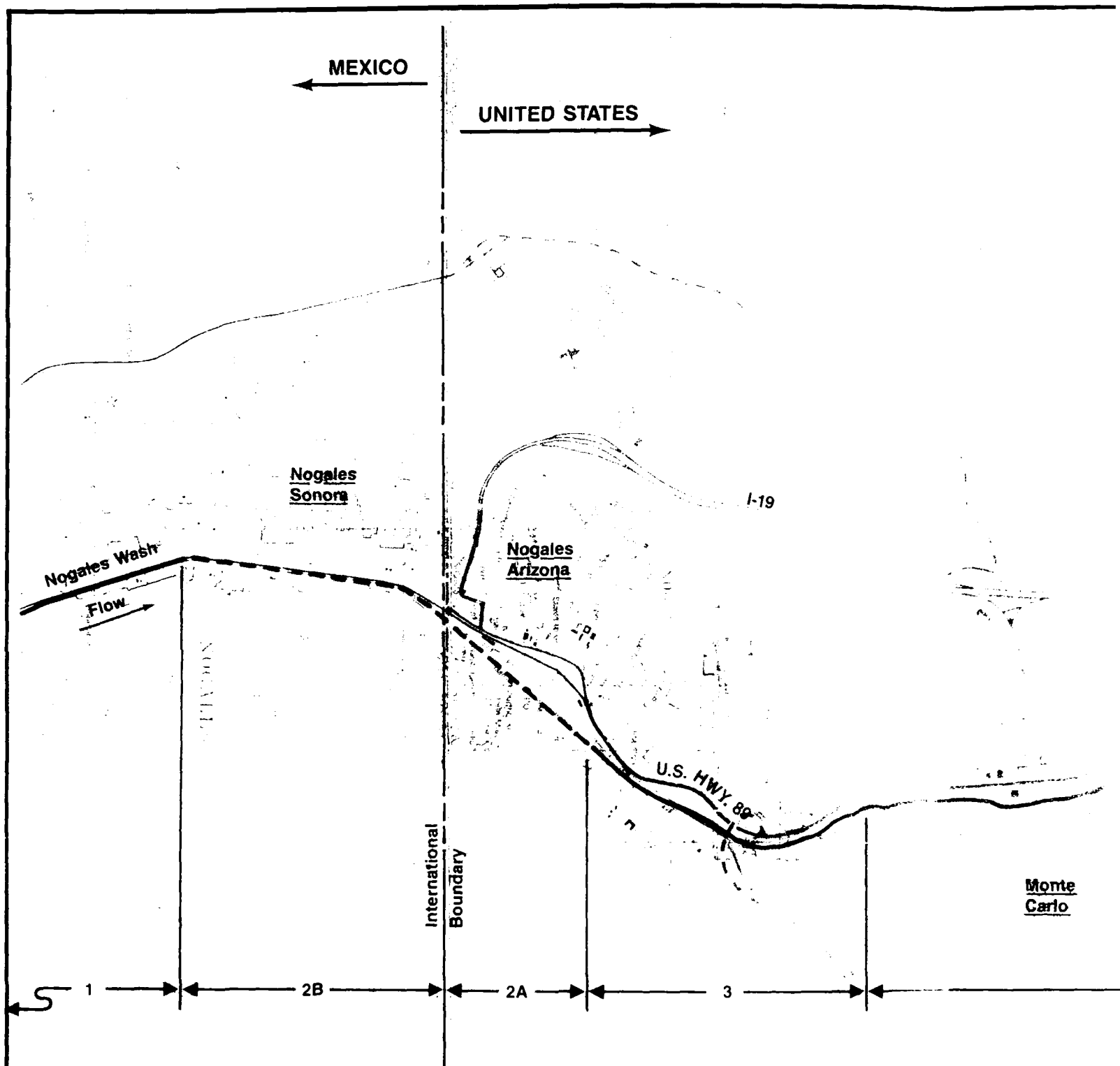


GILA RIVER AND TRIBUTARIES
NOGALES WASH AZ

NOGALES WASH/POTRERO CREEK
DRAINAGE & SUBAREA
BOUNDARIES & HYDROLOGIC
CONCENTRATION POINTS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 1



LEGEND

REACH

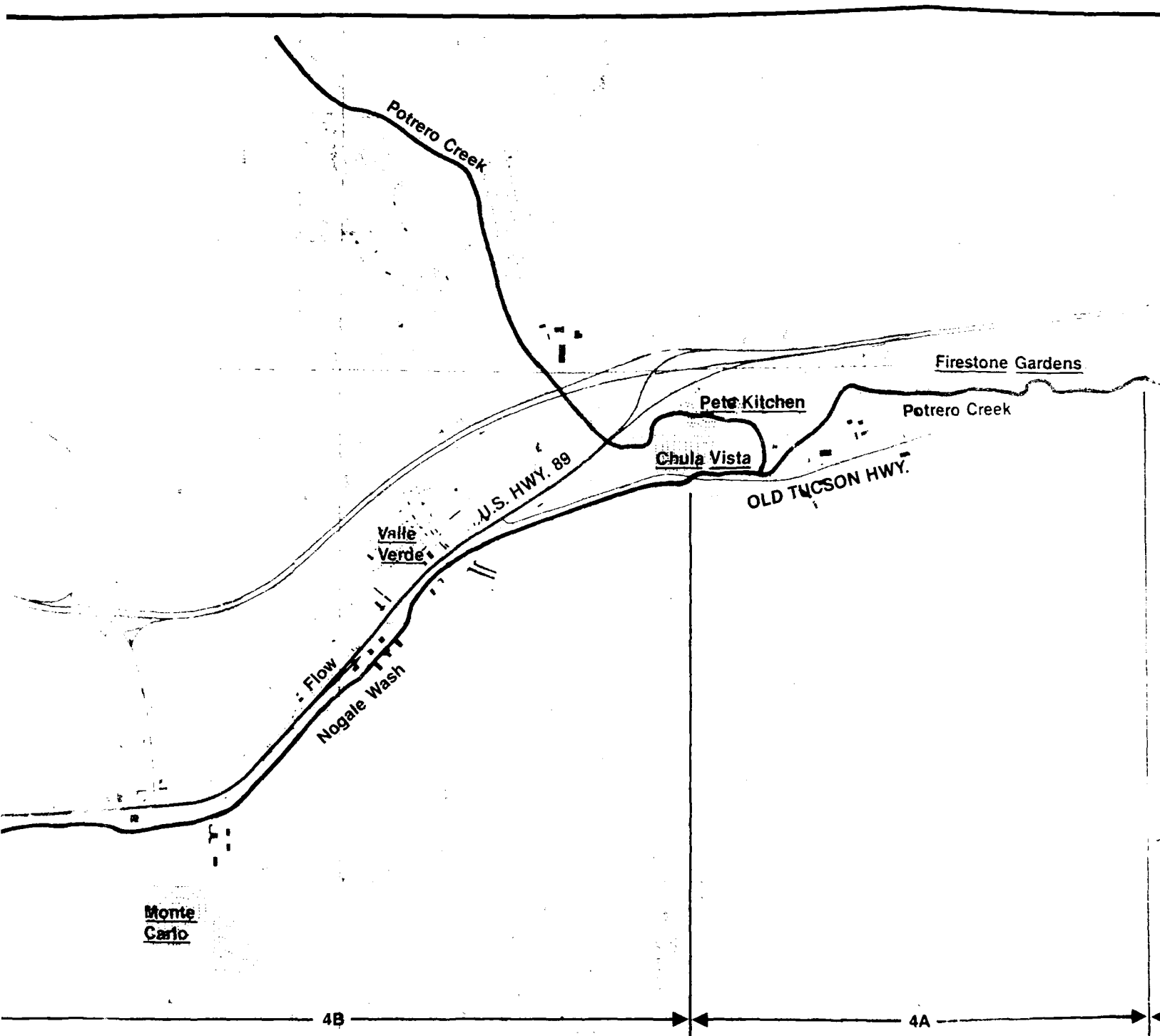
DESCRIPTIVE NAME

REACH

DESCRIPTIVE NAME

1 Upstream Section
 2B Covered Concrete Channel Section in Mexico
 2A Covered Concrete Channel Section in USA
 Open Concrete Channel Section

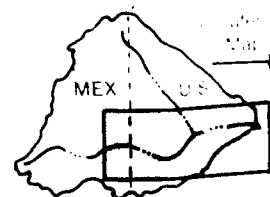
3 Open Concrete Channel Section
 4B Unimproved Section Upstream of Chula Vista
 4A Unimproved Section Downstream of Chula Vista
 5 Downstream Section



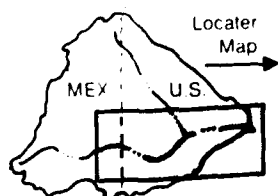
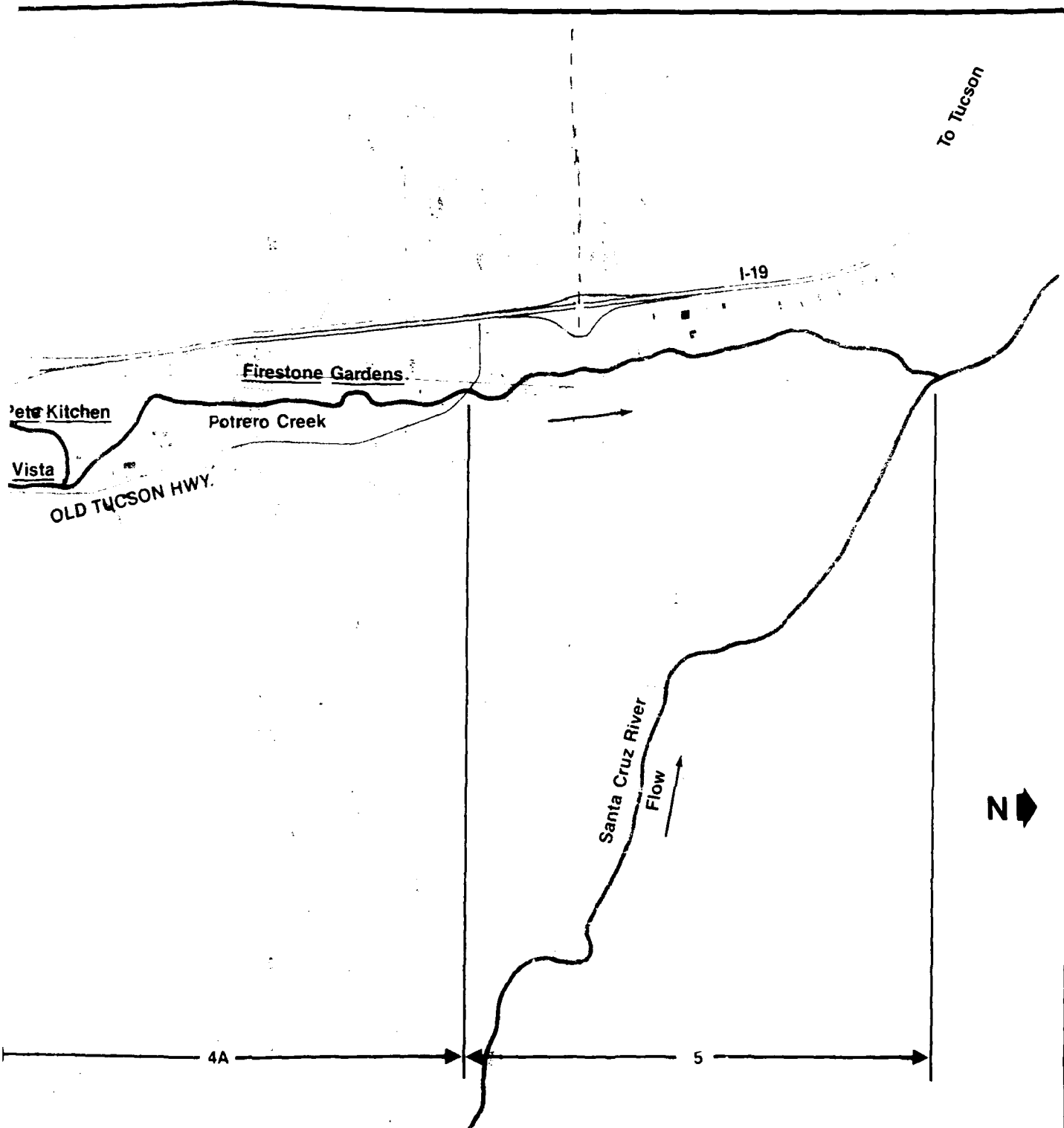
NAME

tion
m of Chula Vista
eam of Chula Vista

—— Main Water Courses
--- Nogales Wash Covered Channel



0 1 mi
SCALE



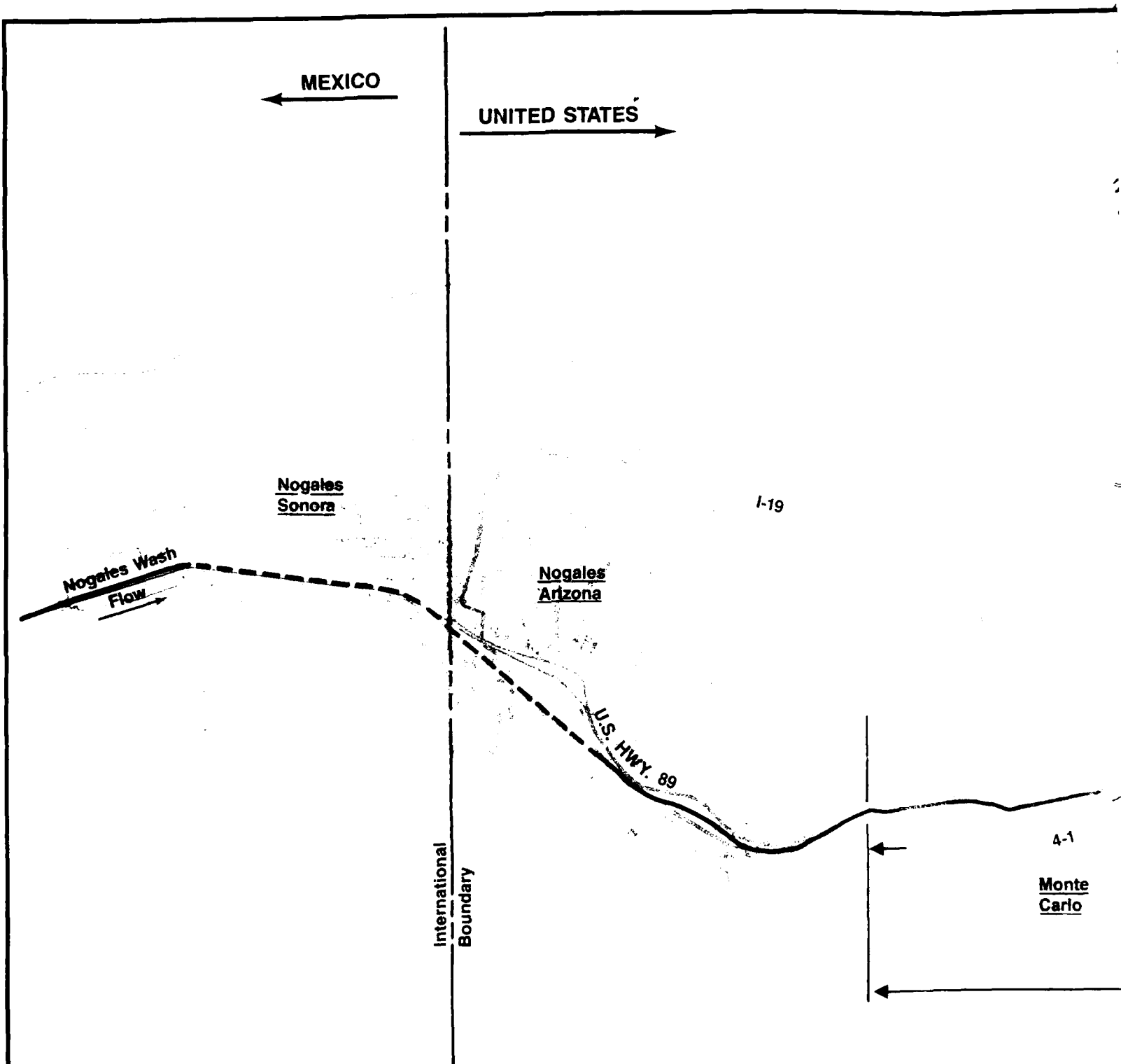
Locator
Map

0 1/4 mi. 1/2 mi. 1 mi.
SCALE 1" = 1/2 MILE

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

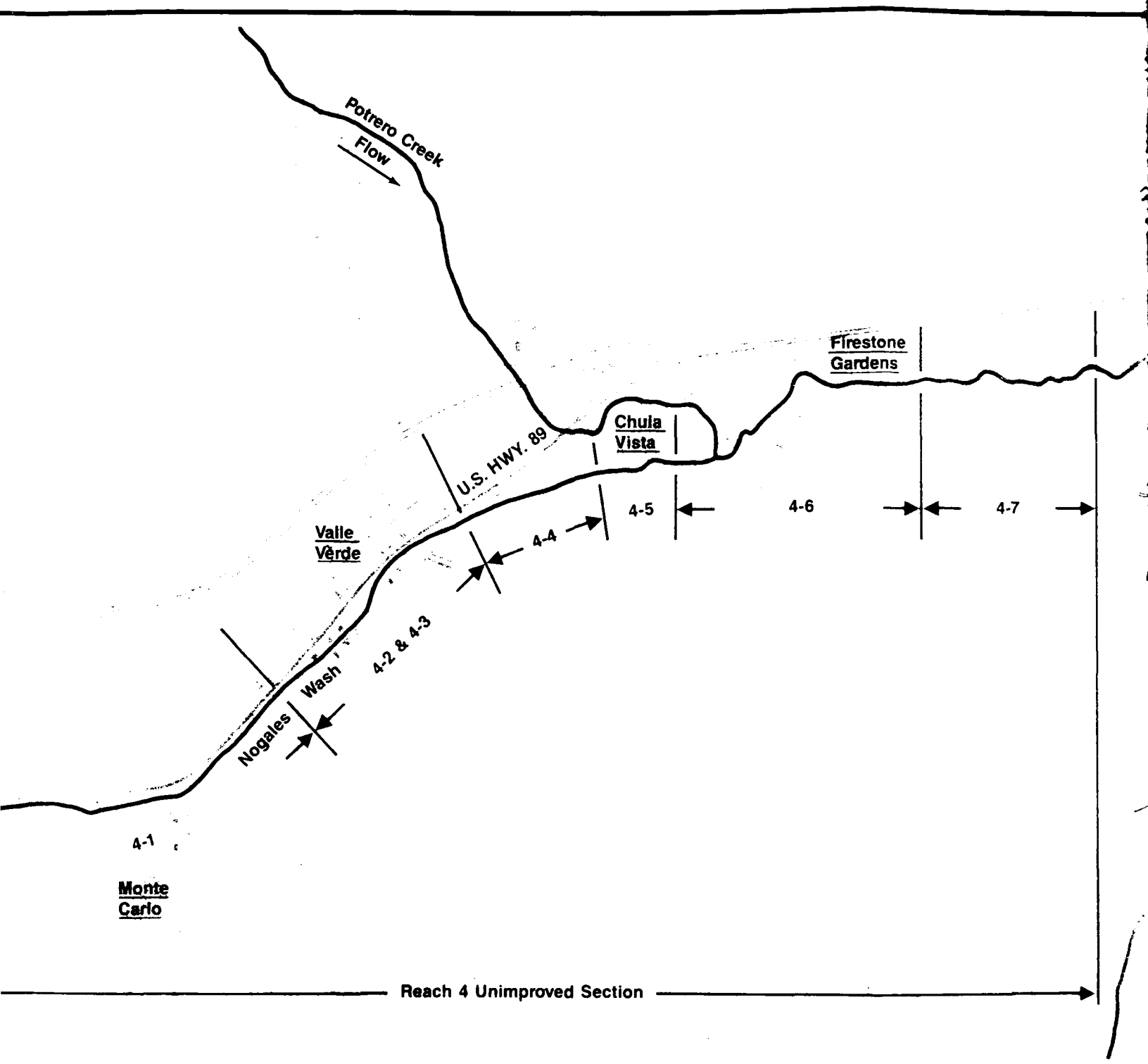
NOGALES WASH/POTRERO CREEK
REACH BREAKDOWN

GILA RIVER & TRIBUTARIES
NOGALES WASH. AZ



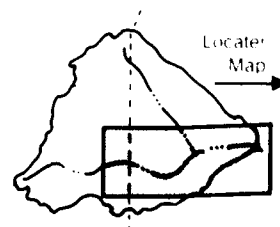
LEGEND

<u>Economic Subreach</u>	<u>Location</u>	
4-1	Monte Carlo	4-5 Chula Vista Community
4-2 and 4-3	Valle Verde Community	4-6 Below Chula Vista Thru Firestone Gardens
4-4	Between Valle Verde & Chula Vista	4-7 Below Firestone Gardens

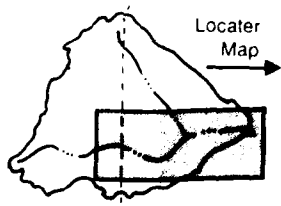
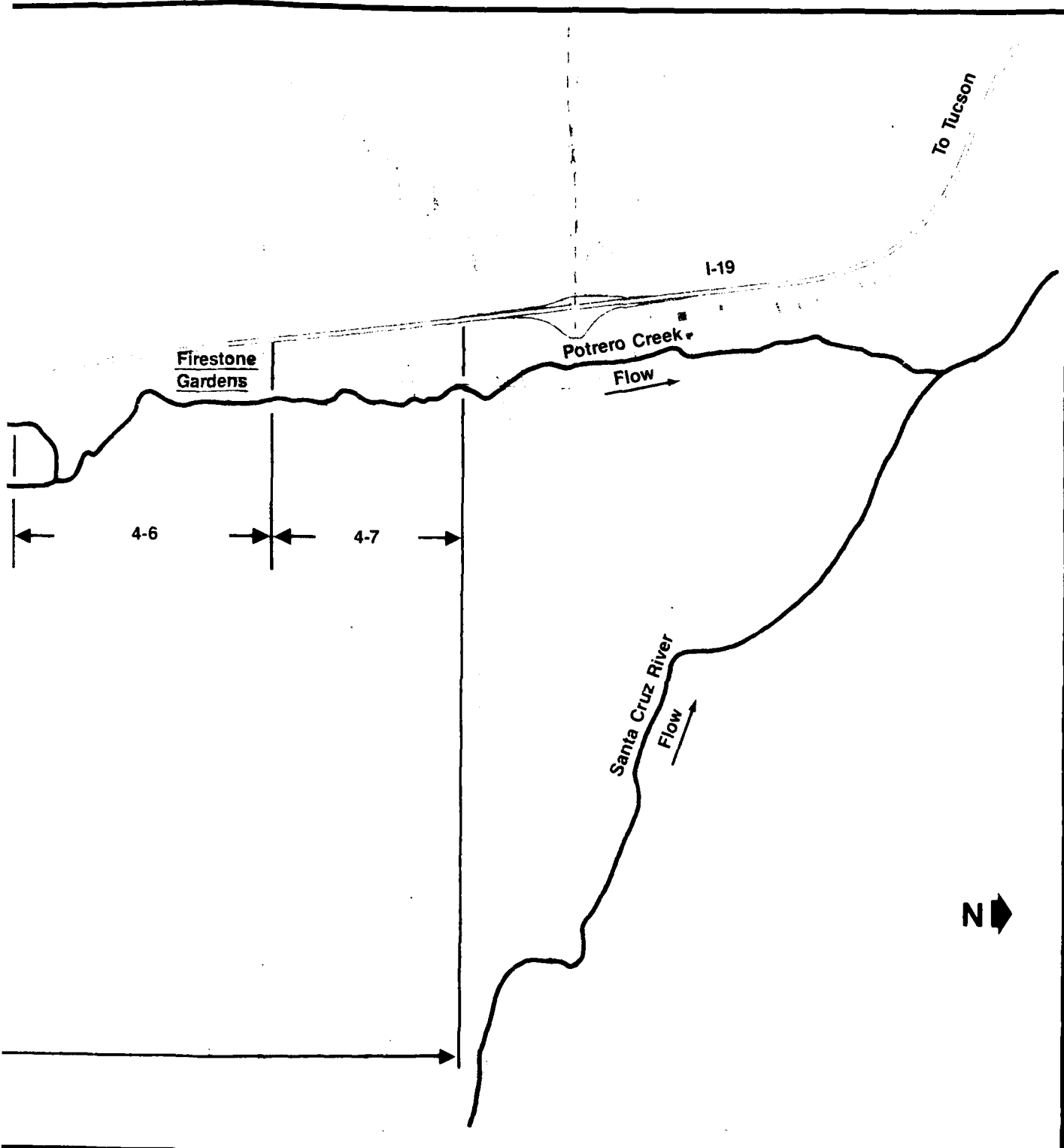


Gardens

- Main Water Courses
- - - - - Nogales Wash Covered Channel

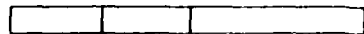


0 1/4 mi. 1/2 mi.
SCALE 1" =



Locator
Map

0 1/4 mi. 1/2 mi. 1 mi.

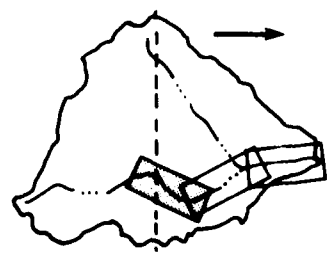
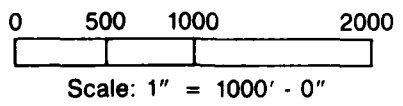


SCALE 1" = 1/2 MILE



GILA RIVER & TRIBUTARIES
NOGALES WASH. AZ

NOGALES WASH/POTRERO CREEK
ECONOMIC SUBREACHES
OF REACH 4

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LEGEND

-  100 Year without and With Project
-  500 Year Without and With Project

100 Year Project in Feet

100 Year Project Depth in

I-19

EPHRAIM CANYON

WASH

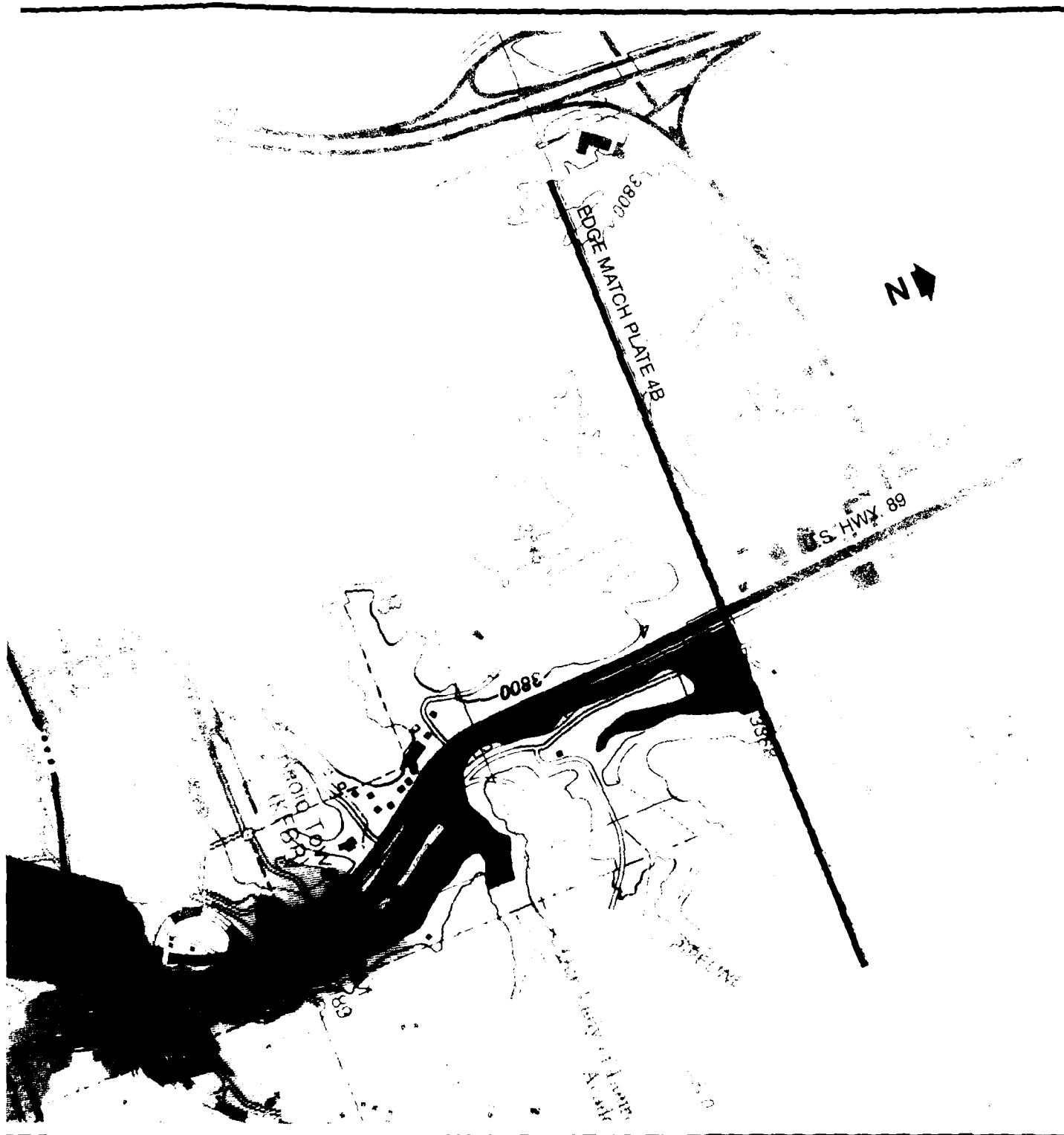
Neogale
Arizona

3.7
3.6

5.1
2.1 5.1

0.0 3.6
0.0 3.8

1.7 3.0
1.2 2.7



NOTES: 1. Differences in the aerial extent of with and without project overflows are not significant at this scale, because of steep valley walls and only minor changes in flood depths for the floods depicted.
2. Overflow data in Mexico is not available.

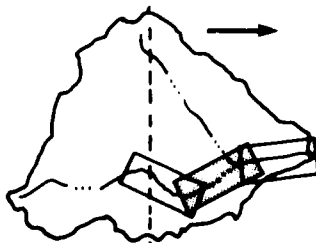
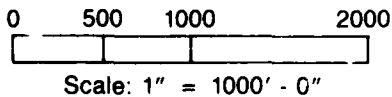
INTERNATIONAL  BOUNDARY

GILA RIVER AND TRIBUTARIES
NOGALES WASH. AZ

AREAS SUBJECT TO
INUNDATION FROM
NOGALES WASH/POTRERO CREEK
MAINSTEM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 4A



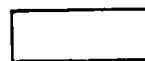
LEGEND



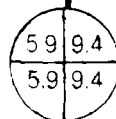
100 Year without
and With Project



Area Removed From
100 Year Floodplain



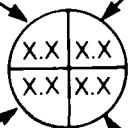
500 Year Without
and With Project



Area Removed From
100 Year Floodplain

100 Year Without
Project Flood Depth
in Feet

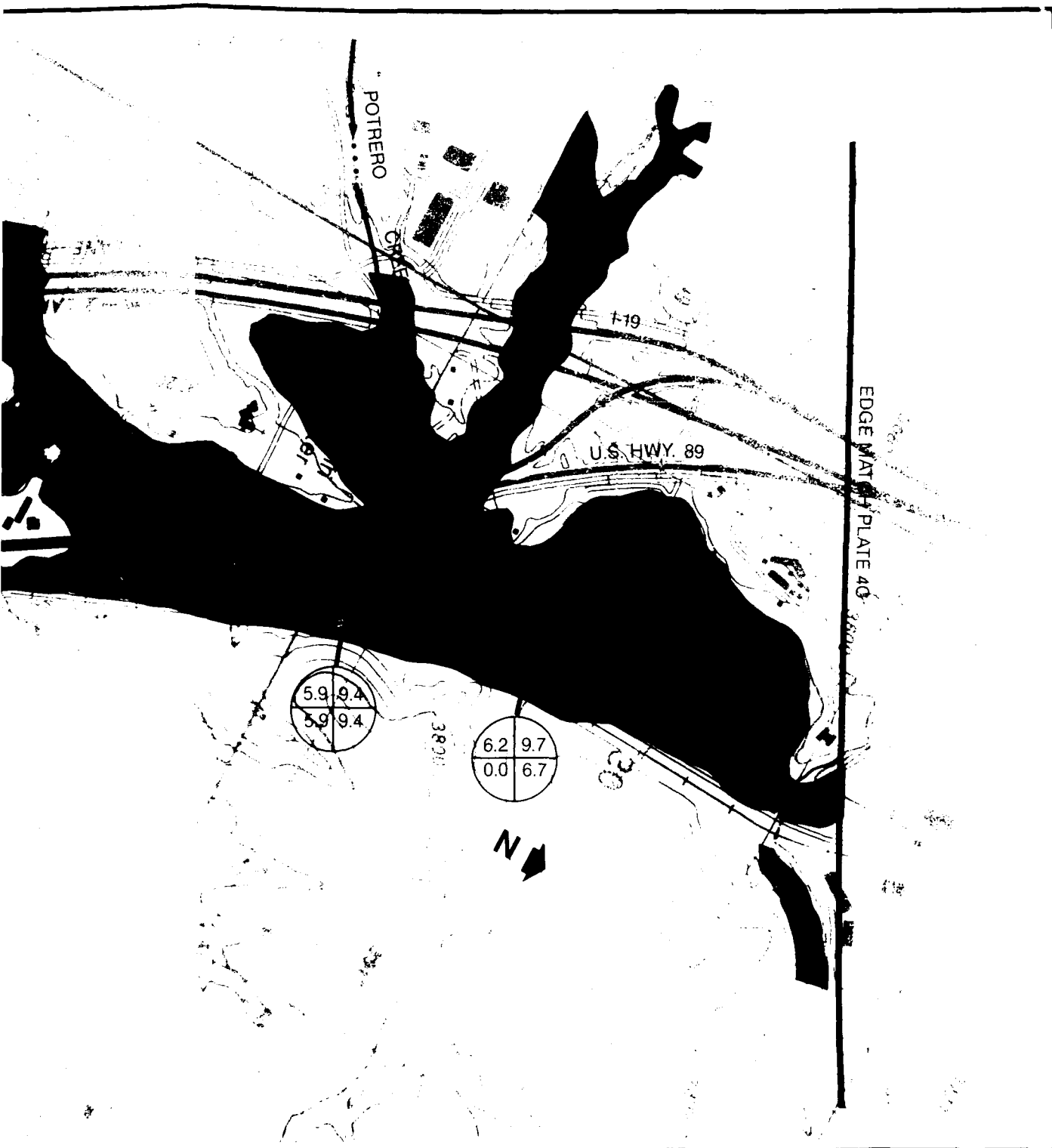
100 Year With
Project Flood
Depth in Feet



500 Year Without
Project Flood Depth
in Feet

500 Year With
Project Flood
Depth in Feet

NOTES: 1. Differences in the aerial extent of with and
overflows are not significant at this scale.
valley walls and only minor changes in flood
floods depicted



ES: 1. Differences in the aerial extent of with and without project overflows are not significant at this scale, because of steep valley walls and only minor changes in flood depths for the floods depicted.

GILA RIVER AND TRIBUTARIES
NOGALES WASH, AZ

AREAS SUBJECT TO
INUNDATION FROM
NOGALES WASH/POTRERO CREEK
MAINSTEM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

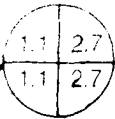
PLATE 4B



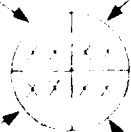
PESQUIEIRA

4-19

stone
pens



High Water Within
Project Flood Depth
in Foot

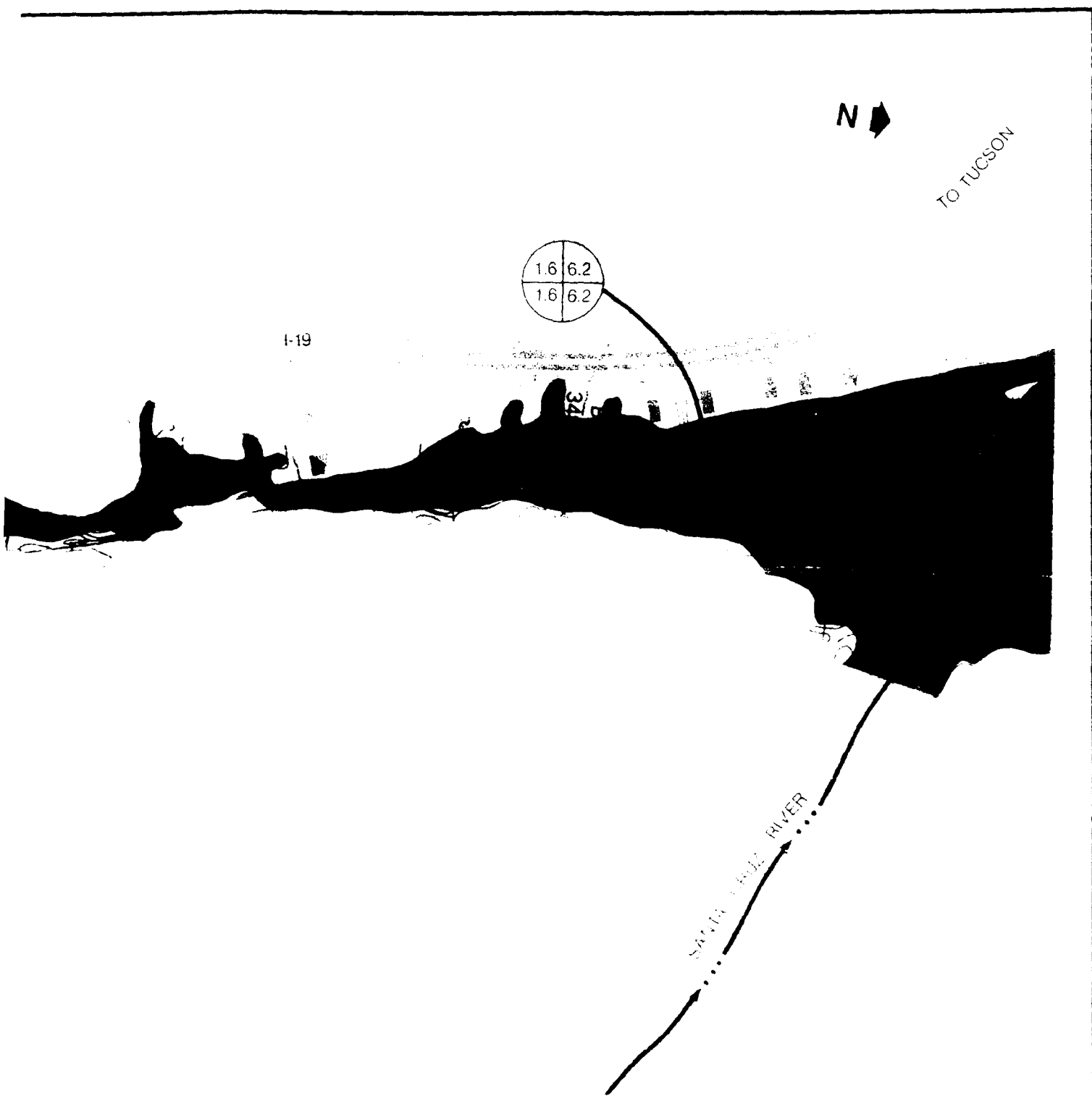


High Water Within
Project Flood Depth
in Foot

High Water Within
Project Flood
Depth in Foot

High Water Within
Project Flood
Depth in Foot

NOTES: 1. Differences in
overflows are
valley walls a
floods depth

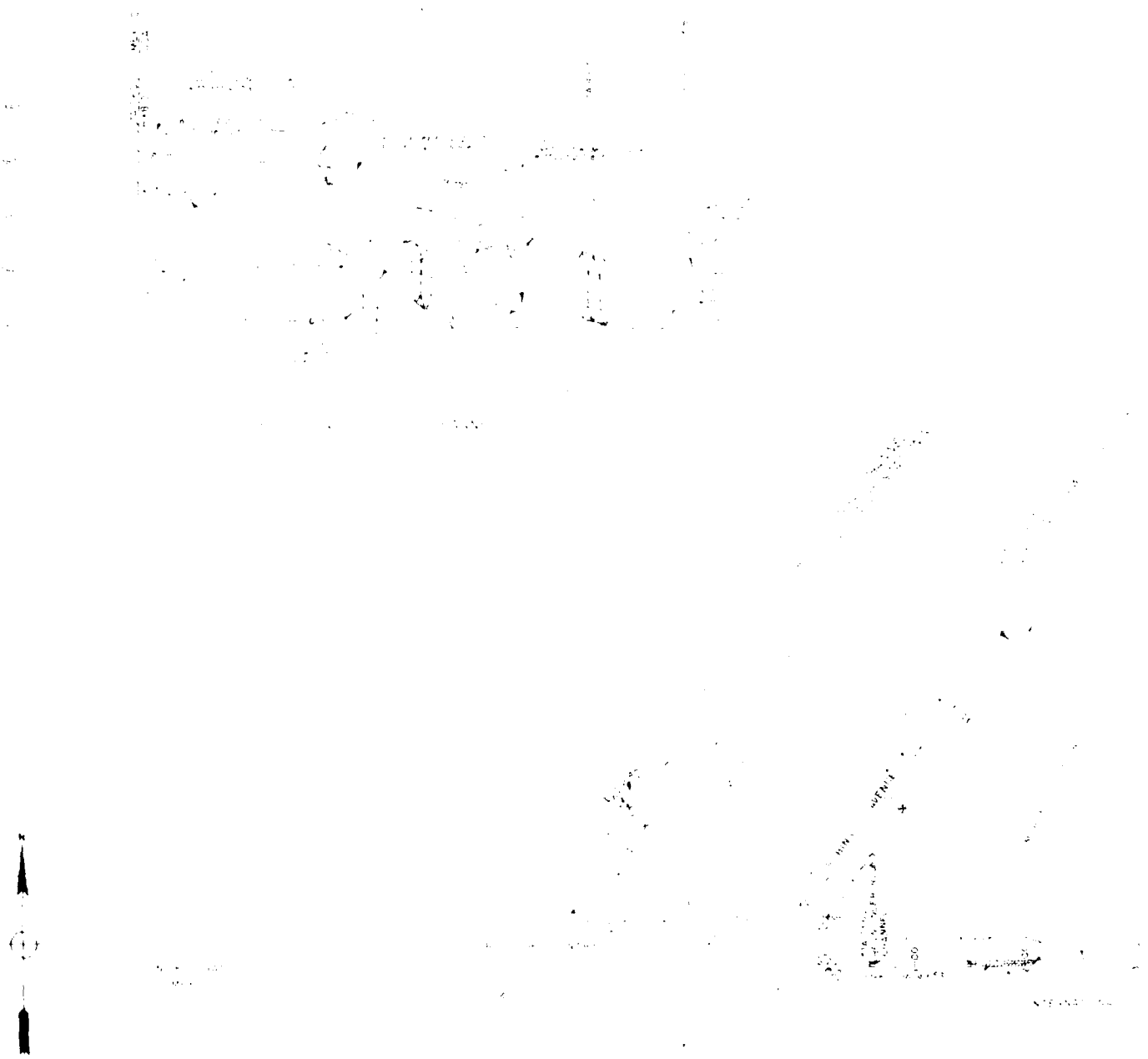


NOTES: 1. Difference in the aerial extent of with and without project operation is not significant at this scale because of steep valley walls and only minor changes in flood depths for the flood shown.

SILA RIVER AND TRIBUTARIES
NOGALES WASH. AZ

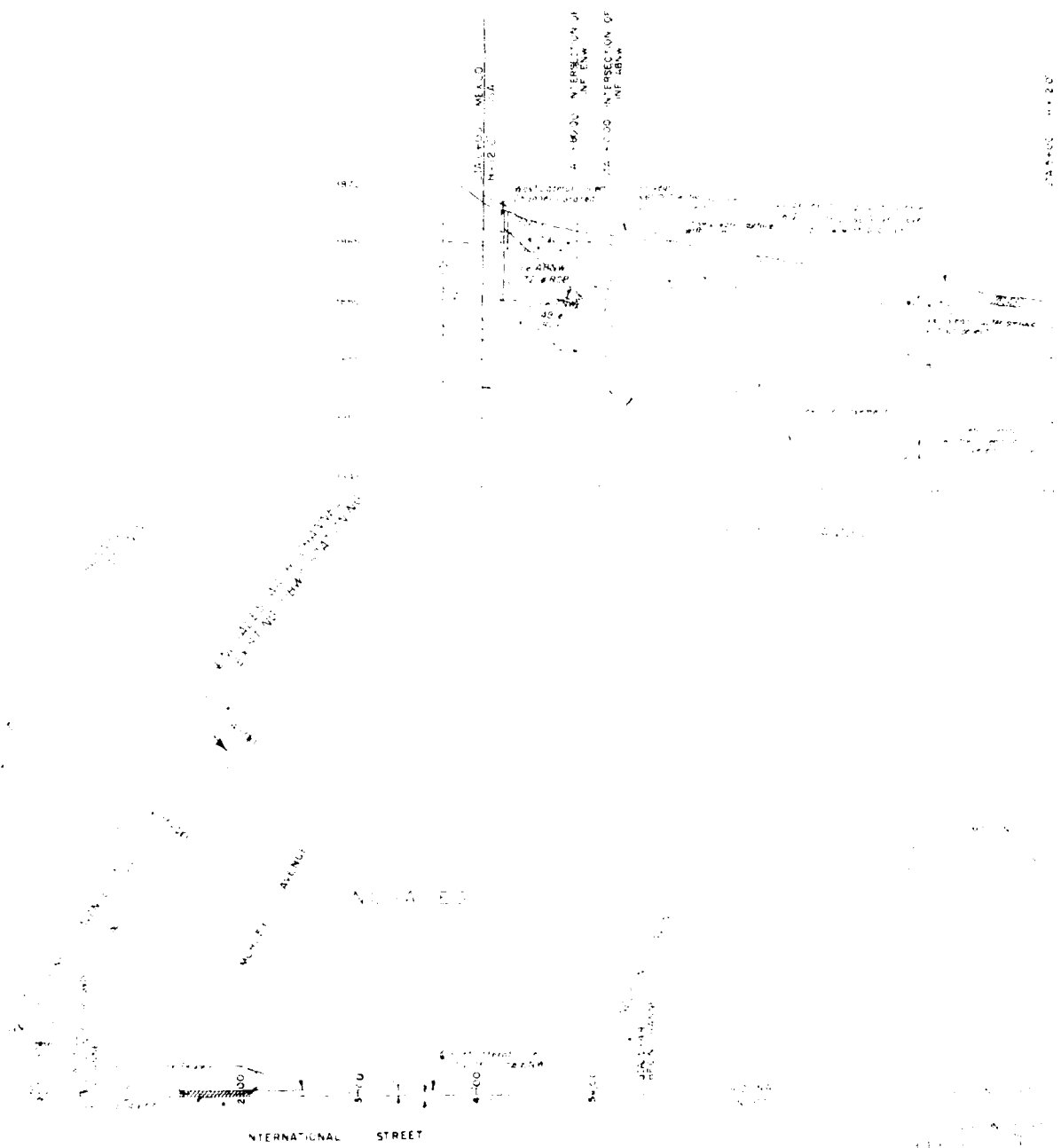
AREAS SUBJECT TO
INUNDATION FROM
NOGALES WASH POTRERO CREEK
MAINSTEM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



LOGALES

PLAN



PROJECT NO. _____ DATE OF PREPARATION _____ DRAWING NO. _____ SCALE _____ SHEET NO. _____ TOTAL SHEETS _____
PLAN AND PROFILE
U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT

PLATE 5

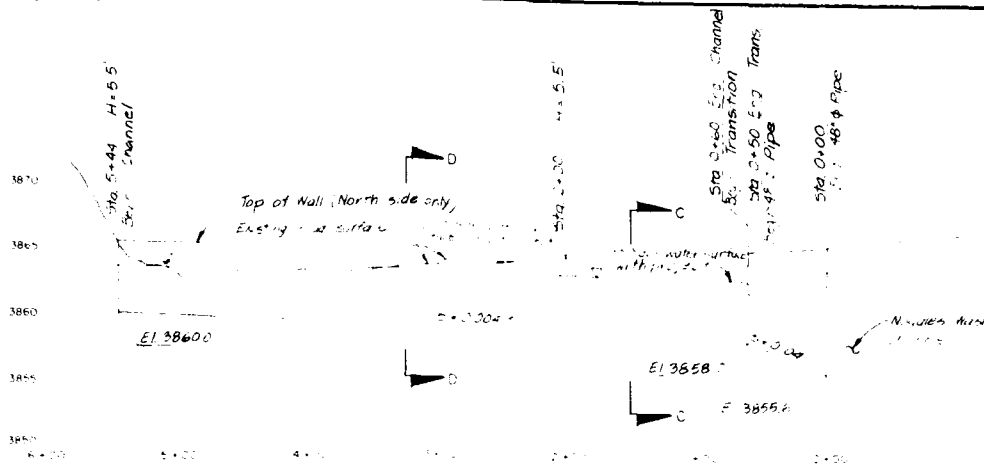


FIG. 1. TRANSVERSE SECTION OF EAST LATERAL COLLECTOR CHANNEL (SEE PLAN)
 1. CHANNEL BED
 2. CHANNEL WALL
 3. CHANNEL FLOOR
 4. CHANNEL TOP
 5. CHANNEL BOTTOM

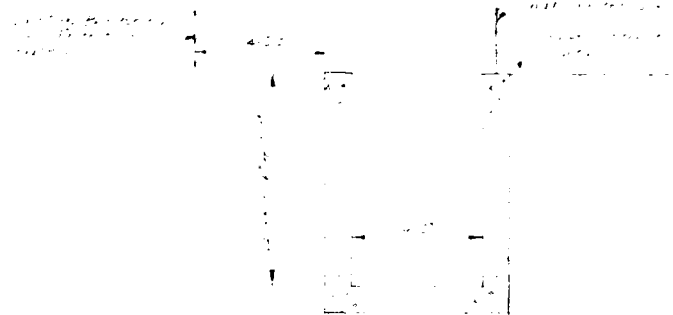


FIG. 2. TYPICAL SECTION - STA 0+00 TO STA 2+00
 NOT TO SCALE

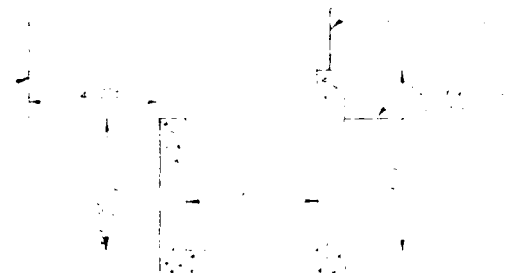
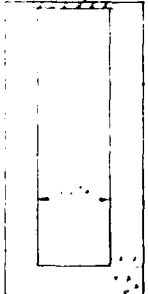


FIG. 3. TYPICAL SECTION - STA 2+00 TO STA 4+00
 NOT TO SCALE

PIPE DIMENSIONS

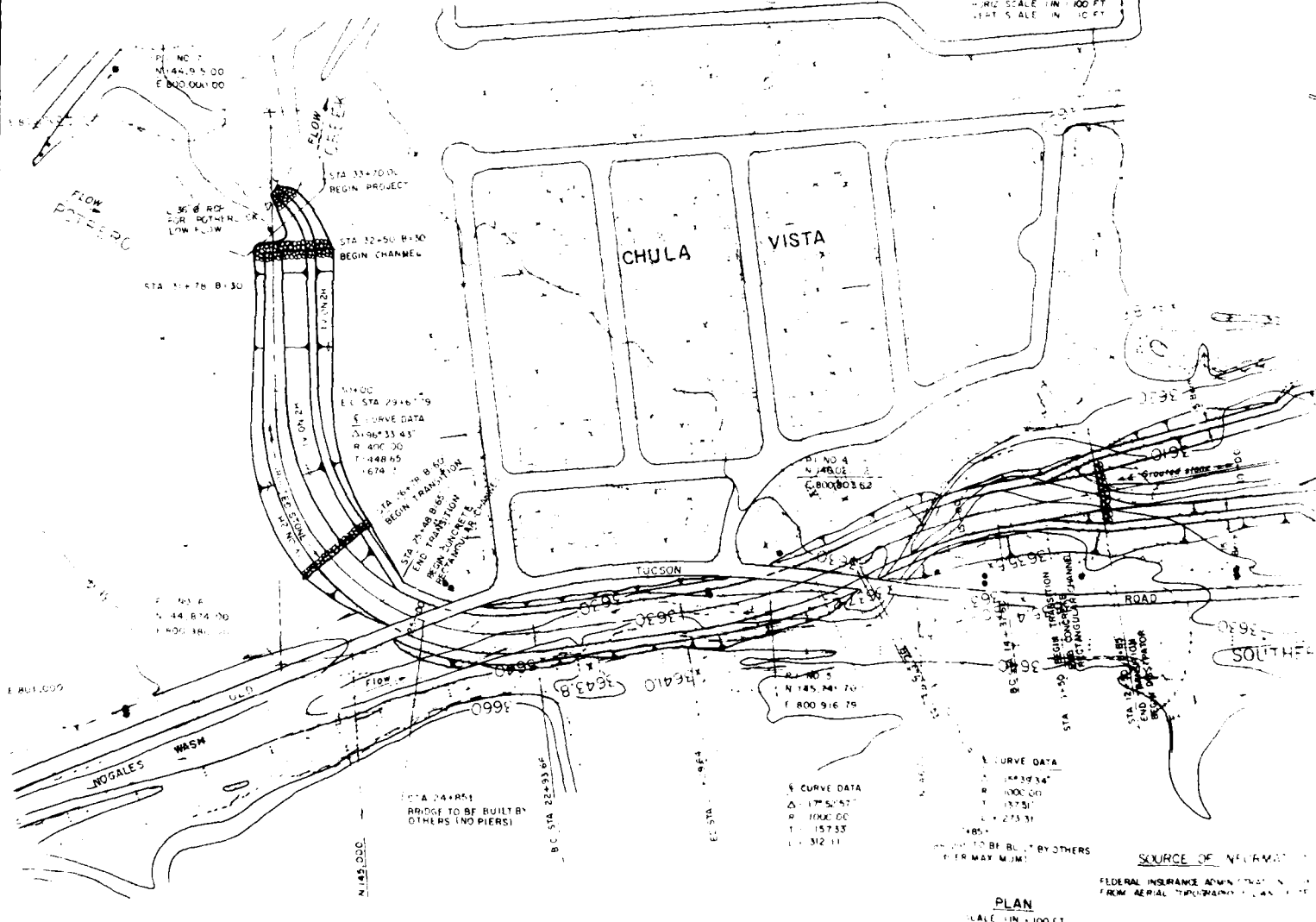
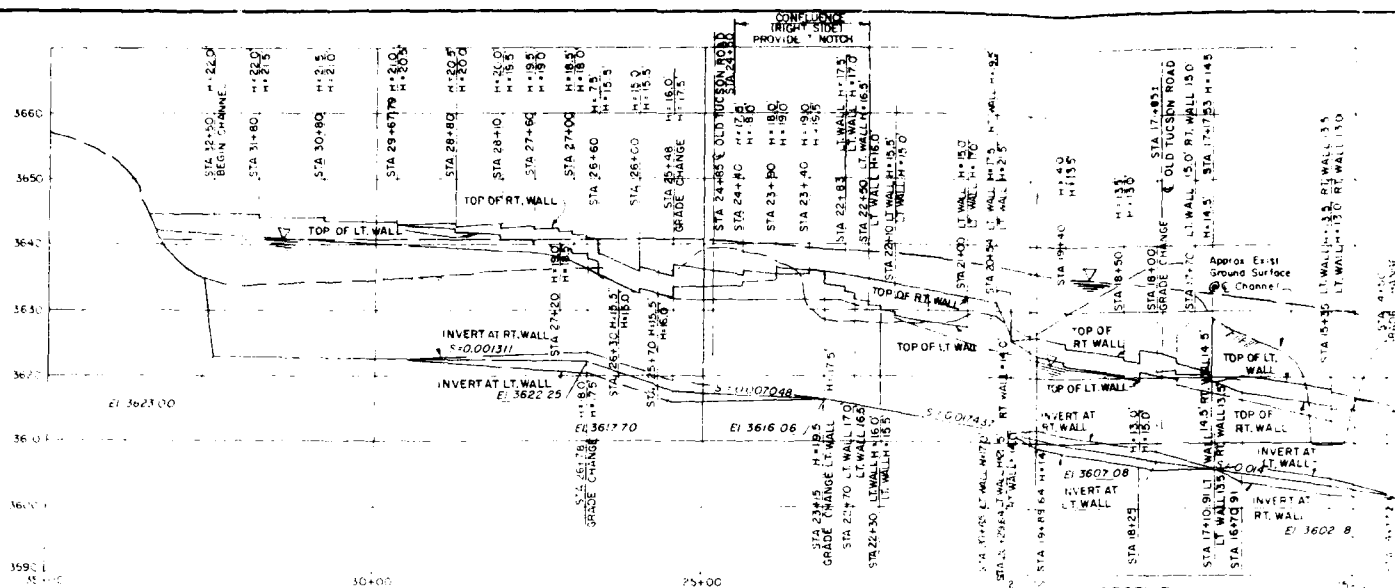
12"	24"	36"
18"	30"	42"
24"	36"	48"
30"	42"	54"
36"	48"	60"
42"	54"	66"
48"	60"	72"
54"	66"	78"
60"	72"	84"
66"	78"	90"
72"	84"	96"
78"	90"	102"
84"	96"	108"
90"	102"	114"
96"	108"	120"
102"	114"	126"
108"	120"	132"
114"	126"	138"
120"	132"	144"
126"	138"	150"
132"	144"	156"
138"	150"	162"
144"	156"	168"
150"	162"	174"
156"	168"	180"
162"	174"	186"
168"	180"	192"
174"	186"	198"
180"	192"	204"
186"	198"	210"
192"	204"	216"
198"	210"	222"
204"	216"	228"
210"	222"	234"
216"	228"	240"
222"	234"	246"
228"	240"	252"
234"	246"	258"
240"	252"	264"
246"	258"	270"
252"	264"	276"
258"	270"	282"
264"	276"	288"
270"	282"	294"
276"	288"	300"
282"	294"	306"
288"	300"	312"
294"	306"	318"
300"	312"	324"
306"	318"	330"
312"	324"	336"
318"	330"	342"
324"	336"	348"
330"	342"	354"
336"	348"	360"
342"	354"	366"
348"	360"	372"
354"	366"	378"
360"	372"	384"
366"	378"	390"
372"	384"	396"
378"	390"	402"
384"	396"	408"
390"	402"	414"
396"	408"	420"
402"	414"	426"
408"	420"	432"
414"	426"	438"
420"	432"	444"
426"	438"	450"
432"	444"	456"
438"	450"	462"
444"	456"	468"
450"	462"	474"
456"	468"	480"
462"	474"	486"
468"	480"	492"
474"	486"	498"
480"	492"	504"
486"	498"	510"
492"	504"	516"
498"	510"	522"
504"	516"	528"
510"	522"	534"
516"	528"	540"
522"	534"	546"
528"	540"	552"
534"	546"	558"
540"	552"	564"
546"	558"	570"
552"	564"	576"
558"	570"	582"
564"	576"	588"
570"	582"	594"
576"	588"	600"
582"	594"	606"
588"	600"	612"
594"	606"	618"
600"	612"	624"
606"	618"	630"
612"	630"	636"
618"	636"	642"
624"	642"	648"
630"	648"	654"
636"	654"	660"
642"	660"	666"
648"	666"	672"
654"	672"	678"
660"	678"	684"
666"	684"	690"
672"	690"	696"
678"	696"	702"
684"	702"	708"
690"	708"	714"
696"	714"	720"
702"	720"	726"
708"	726"	732"
714"	732"	738"
720"	738"	744"
726"	744"	750"
732"	750"	756"
738"	756"	762"
744"	762"	768"
750"	768"	774"
756"	774"	780"
762"	780"	786"
768"	786"	792"
774"	792"	798"
780"	798"	804"
786"	804"	810"
792"	810"	816"
798"	816"	822"
804"	822"	828"
810"	828"	834"
816"	834"	840"
822"	840"	846"
828"	846"	852"
834"	852"	858"
840"	858"	864"
846"	864"	870"
852"	870"	876"
858"	876"	882"
864"	882"	888"
870"	888"	894"
876"	894"	900"
882"	900"	906"
888"	906"	912"
894"	912"	918"
900"	918"	924"
906"	924"	930"
912"	930"	936"
918"	936"	942"
924"	942"	948"
930"	948"	954"
936"	954"	960"
942"	960"	966"
948"	966"	972"
954"	972"	978"
960"	978"	984"
966"	984"	990"
972"	990"	996"
978"	996"	1000"

FIG. 4. TYPICAL SECTION FOR PIPE INSTALLATION
 NOT TO SCALE

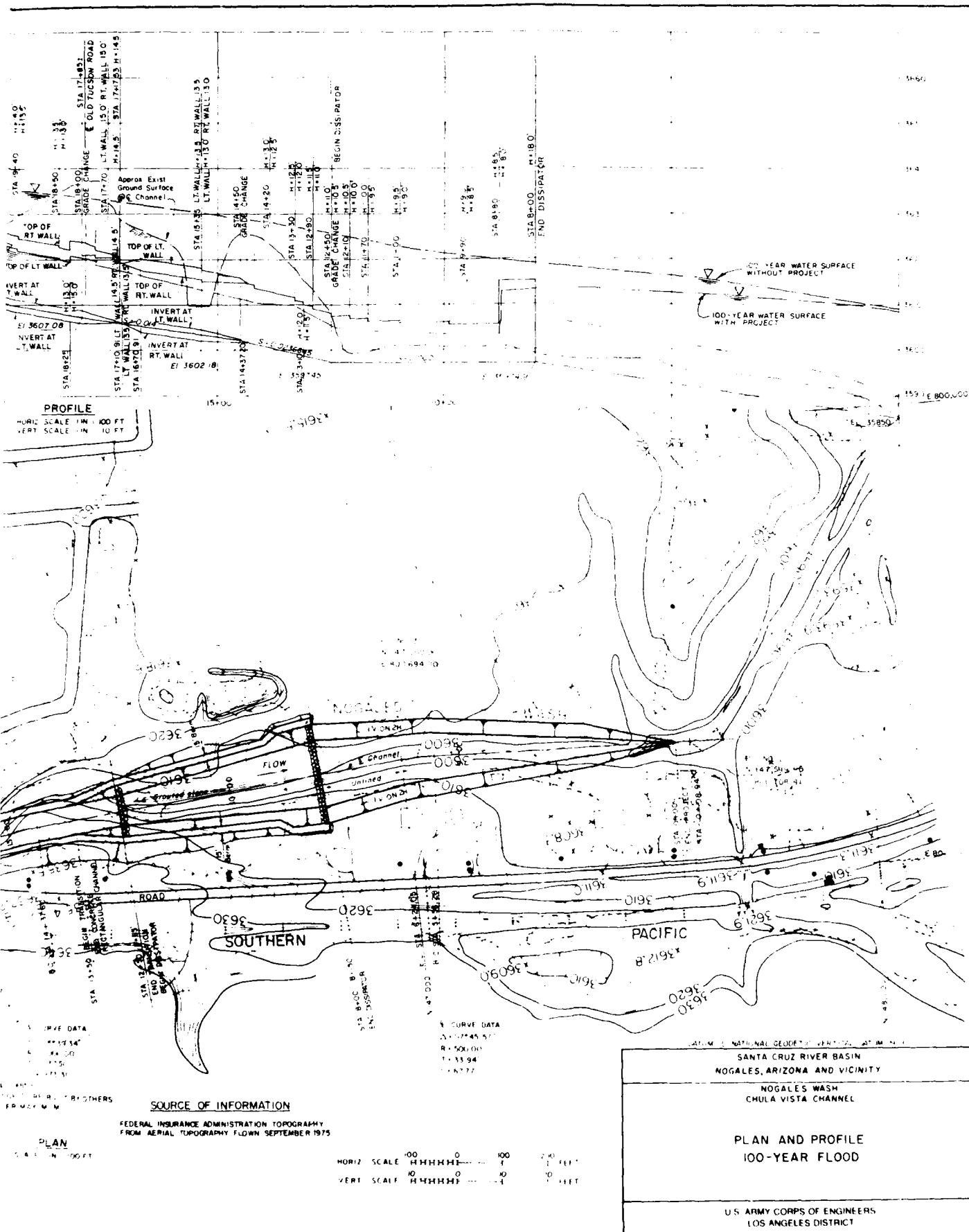


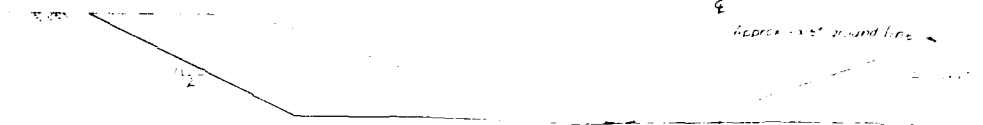
SECTION B-B (TYPICAL)
 DROP INLET
 NOT TO SCALE

SANTA CRUZ RIVER BASIN NOGALES, ARIZONA AND VICINITY NOGALES WASH LATERAL COLLECTOR CHANNELS DETAIL PLAN AND TYPICAL SECTIONS U.S. ARMY CORPS OF ENGINEERS LOS ANGELES DISTRICT



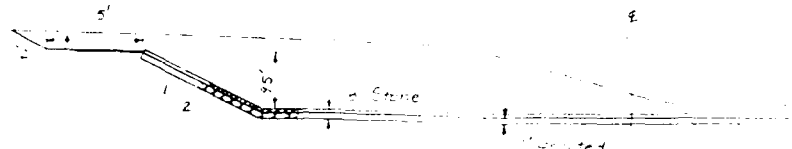
SOURCE OF INFORMATION
 FEDERAL INSURANCE ADMINISTRATION
 FROM AERIAL PHOTOGRAPHY, 1945





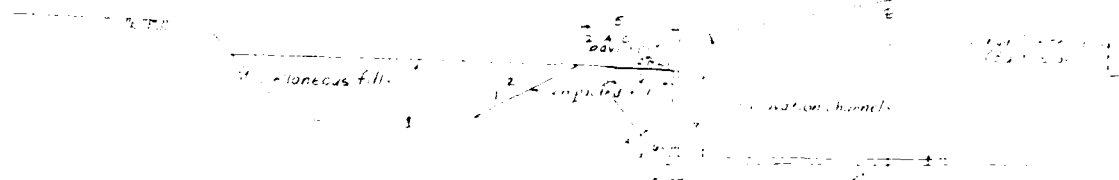
STA 7+00

Note 1" of stone protrudes above grout for energy dissipation.



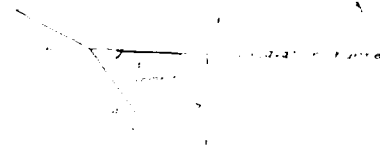
STA 10+00

Approx. ext. ground line



STA 14+50

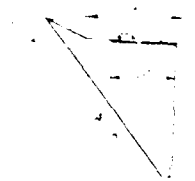
Approx. ext. ground line



STA 16+00

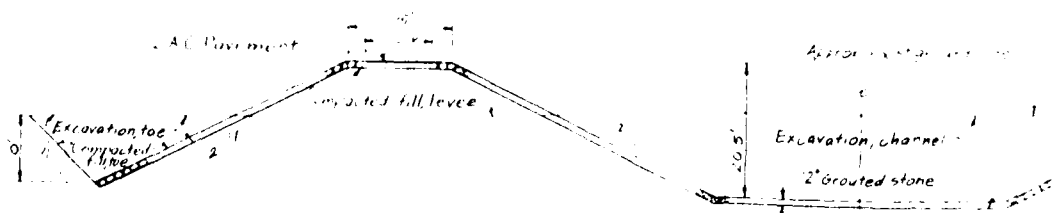
Approx. ext. ground line

Excavation, toe



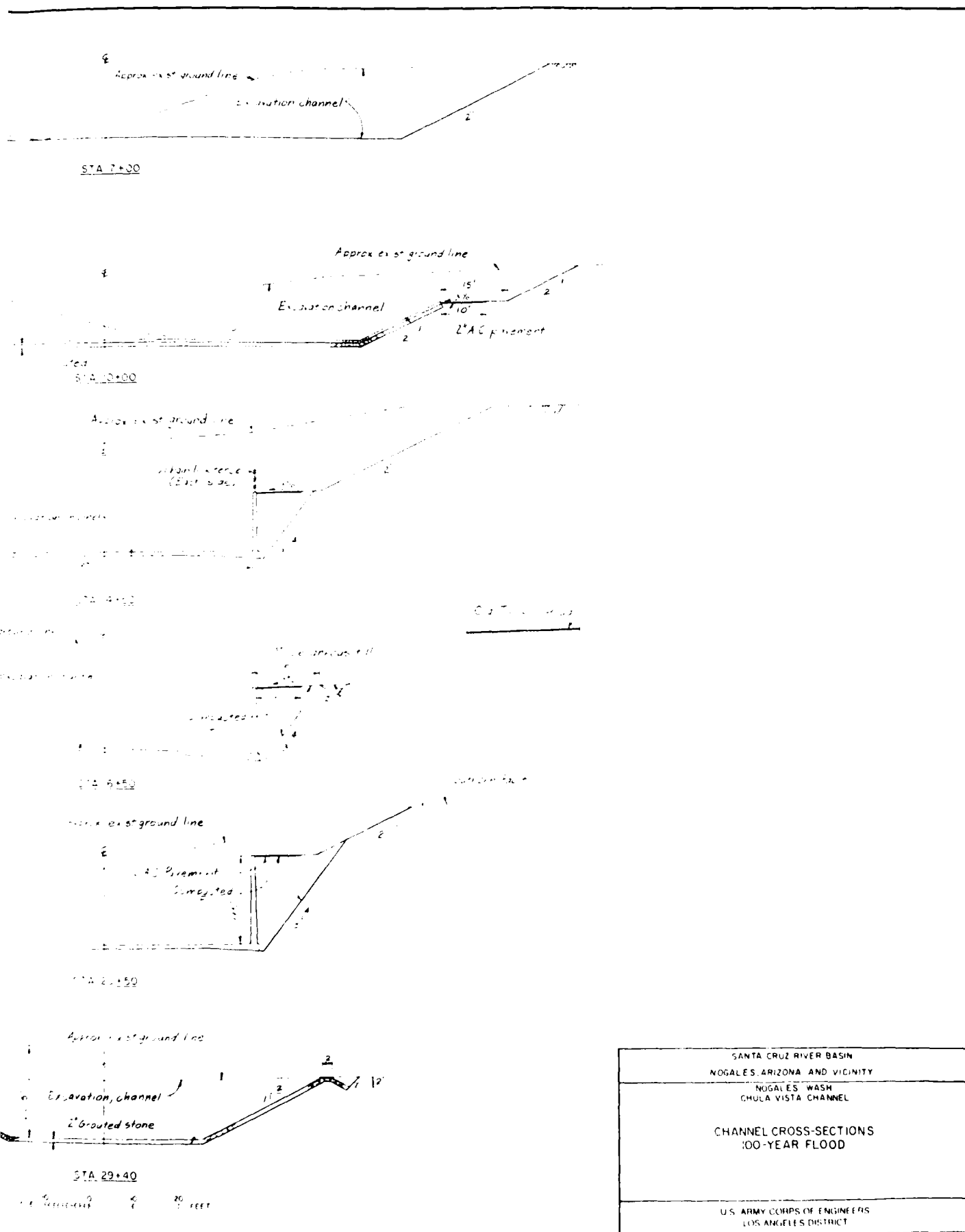
STA 20+50

Approx. ext. ground line



STA 29+40

Approx. ext. ground line



APPENDIX A
PUBLIC RESPONSE TO DRAFT REPORT

The Draft Feasibility Report and Environmental Assessment, Nogales Wash and Tributaries, Nogales, Arizona, was available for public review and comment from November 20, 1987 to December 20, 1987. Copies of the draft report were sent to Santa Cruz County, the City of Nogales, interested State and Federal Agencies, and various private firms and individuals. The draft report was also provided to the Arizona State Clearinghouse (SAI No: 87-80-0059) and to the Nogales City Library.

Comments received were generally in support of the proposed project, although several respondents identified concerns and/or provided differing opinions/judgments in regard to engineering and environmental technical analysis.

Letters from the International Boundary and Water Commission (page A-2), Arizona Department of Commerce (page A-10), and Arizona State Lands Department (page A-20) were supportive, and their comments, where appropriate, were incorporated into the text of this final report.

Environmental concerns/comments expressed by the U.S. Fish and Wildlife Service (page A-8), Arizona Game and Fish Department (page A-11), and Arizona Department of Environmental Quality (page A-12) are addressed in the attached Environmental Assessment.

Specific comments made by the United States Department of Agriculture, Soil Conservation Service (page A-5), and Arizona Department of Water Resources (page A-15) have been addressed on those letters, in this appendix.



OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

INTERNATIONAL BOUNDARY AND WATER COMMISSION

UNITED STATES AND MEXICO

THE COMMONS, BUILDING C, SUITE 310

4171 NORTH MESA

EL PASO, TEXAS 79902

District Engineer
U.S. Army Corps of Engineers
Attn: Mr. Paul Blakey
Water Resource Branch
P.O. Box 2711
Los Angeles, California 90053-2325

Dear Sir:

We have reviewed the Draft Feasibility Report and Draft Environmental Assessment for the Proposed Nogales Wash and Tributaries, Nogales, Arizona Project. We have no objection to the "Plan Tentatively Selected for Implementation? However, we will have to discuss the plan with the Mexican Section to obtain permission for installation of the self reporting rain and stream gages in Mexico.

The report is very comprehensive. However, we feel that the report could be made more readable if much of the material on the Corps planning procedures was left out. At the same time, we feel that more detail is needed on the economic analysis. We presume that the first costs were converted to annual costs. If so what interest rate and period of time were used. Also, more information on the flood frequency analysis is needed. It is not clear how you can have two different frequencies for the same flow. In addition, it is not clear as to what would happen if the inlets to the existing covered channels were cleaned out.

As mentioned in the report the U.S. Section is working with the City of Nogales on the enlargement of the Nogales International Wastewater Treatment Plant. However, there are no plans to enlarge the capacity of the present sewer line from Mexico.

Attached are more detailed comments.

Sincerely,

Thomas P. Wootton
Division Engineer, Planning

Attachment:
As Stated

1. The first of these is the fact that the
the number of people who are
the number of people who are

2. The second of these is the fact that the
the number of people who are

3. The third of these is the fact that the
the number of people who are

4.

5. The fifth of these is the fact that the
the number of people who are

6. The sixth of these is the fact that the
the number of people who are



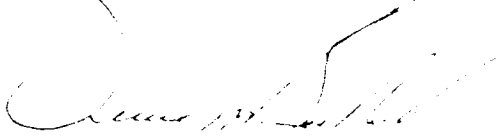
OFFICE OF THE
ATTORNEY GENERAL
STATE OF NEW YORK

ALBANY, N. Y.

the location within the study area. We doubt if these differences will have much effect on the base flood elevations used in the EIR, but perhaps this should be discussed in your report, and RMA be informed of the differences.

We are sorry for the delay in getting our comments to you, but we think they will be of benefit.

Sincerely,



Verne M. Rathbun
State Conservationist

water Resource Investigations Report 84-4142 Tucson, Arizona, 1984" than what the FEMA report used.

c. Corps analysis is based upon expected probability whereas FEMA is not.



**UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE**

ECOLOGICAL SERVICES
3616 W. Thomas, Suite 6
Phoenix, Arizona 85019

December 18, 1987

Colonel Tadahiko Ono
District Engineer
ATTN: Paul Blakey, Water Resources Branch
U.S. Army Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053-2325

Dear Colonel Ono:

This responds to your request for comments on the draft Feasibility Report and draft Environmental Assessment for the proposed Nogales Wash and Tributaries, Nogales, Arizona flood control project. The Fish and Wildlife Service has reviewed the subject draft document and would like to offer the following comments for your consideration.

General Comments

Overall we believe that the documents are comprehensive and adequately address the issues involved with this flood control project.

The mitigation plan presented in the documents would fully mitigate for any project related losses in riparian areas. It includes both vegetative enhancement and acquisition of existing habitats to provide mitigation areas. Additional high value wetland and riparian habitats occur within the drainage basin that may be useful for any further consideration given to mitigation, especially if the present mitigation plan is reviewed for potential modification. An example of these areas would be the wetland located on Patrons Creek, upstream of the project area near Interstate 19.

More information concerning the aesthetic treatment along the Chula Vista Channels (CVC) should be presented in the documents. The feasibility report states that an easement of 10 feet per side of a project is usually acquired. The placement of 10 foot paved maintenance roads on either side of the Chula Vista-Nogales Wash Channel (pages 5-14) may preclude the placement of riparian vegetation in the area except in the 1-tree thick screen. Please elaborate on the actual width and length of these planting areas.

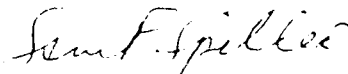
We recommend that as part of the mitigation package, a set of specific management directions be developed for the riparian mitigation areas. These should address watering, planting of replacement vegetation, pruning and trimming, use of herbicides and other related information. We believe that a monitoring plan would be necessary to ensure that trees were planted and survive. Plans for replacement of failed plantings would also be essential.

Specific Comments

- Page 2-1, Section A, 2nd paragraph - Perhaps a figure showing the stream nomenclature to be used would clarify this paragraph.
- Page 3-16, Table 14 - Add "portion" to "Max. supply in the U.S. _____ of the study area."
- Page 4-31 - The last sentence on page 4-31 to page 4-32 appears to be inappropriate.
- Page 5-5,5-6, Table 23 - Further discussion is needed in the text of the feasibility report concerning the 20-25 acres of land that would be removed from the floodplain subject to development.
- Page 5-14 - Dewatering the construction area should not effect adjacent riparian areas.
- Page EA-7 - Techniques developed by the Soil Conservation Service for pole planting in Arizona should be considered.
- Page EA-13, Section 6.1 - Please clarify the status of riparian resources on the disposal site.
- Page EA-21 - Will the right-of-way be planted to be cottonwood-willow and mesquite, or only cottonwood-willow?
- Page EA-26, Section 7.5.2 - The affect of lowering the ground water on riparian vegetation needs to be addressed.
- Page HEP-13 - If the lands identified for mitigation would cost more than \$1,000/acre, would they still be acquired, or would the amount of mitigation land purchased be reduced to maintain stated mitigation costs?

Thank you for the opportunity to comment on these documents. If we may be of further assistance, please contact Ms. Lesley Fitzpatrick or me (Telephone: 602/261-4720).

Sincerely,



Sam F. Spiller
Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, New Mexico
(Fish and Wildlife Enhancement)
Director, Arizona Game and Fish Department, Phoenix, Arizona

MEMORANDUM

TO : U.S. Army Corps of Engineers
FROM: Arizona State Clearinghouse
DATE: December 16, 1987
RE : Draft Feasibility Report and Draft
Environmental Assessment for the proposed Nogales
Wash and Tributaries Nogales, AZ.
SAI NO: AZ 87-80-0059

This memorandum is in response to the above project submitted to the Arizona State Clearinghouse for review.

The project has been reviewed pursuant to the Executive Order 12372 by certain Arizona State officials and Regional Councils of Government.

The Standard Form 424 is attached along with any comments that were received for submission with the project. The comments are advisory.

Attachments

cc: Arizona State Clearinghouse
Applicant

EVAN MECHAM, Governor

Commissioners:
FRED S. BAKER, Elgin, Chairman
LARRY D. ADAMS, Bullhead City
FRANCIS W. WERNER, Tucson
THOMAS G. WOODS, JR., Phoenix
PHILLIP W. ASHCROFT, Eager

Director:
TEMPLE A. REYNOLDS

Assistant Director:
DUANE L. SHROUFE



ARIZONA GAME & FISH DEPARTMENT

2222 West Greenway Road Phoenix, Arizona 85023 942-3000

December 16, 1987

Colonel Tadahiko Ono, District Engineer
U. S. Army Corps of Engineers
Los Angeles District
P. O. Box 2711
Los Angeles, California 90053-2325

Attn: Mr. Paul Balkey, Water Resources Branch

Dear Colonel Ono:

Re: Nogales Wash and Tributaries
Draft Feasibility Report and
Environmental Assessment

The Arizona Game and Fish Department has reviewed the above-referenced document, and has found that it accurately and adequately describes the project and its impacts on biotic resources.

However, we strongly recommend including an additional wetland in section 4.3, subsection 1, page 9, of the draft EA. The wetland is located between I-19 and U.S. 89, in association with Portrero Creek, and should be acquired as mitigation for this project. This wetland provides nesting habitat for the black-bellied whistling duck (Dendrocygna autumnalis fulgens), an Arizona Group 4 threatened native wildlife species.

Thank you for the opportunity to review and comment on this document.

Sincerely,

Robert K. Weaver
Habitat Evaluation Coordinator
Planning and Evaluation Branch

RKW:11

cc: Sam Spiller, Field Supervisor, USFWS, Phoenix ES Office
Tom Spalding, Supervisor, Tucson Regional Office
Bruce Palmer, Nongame Habitat Specialist



ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

EVAN MECHAM, GOVERNOR
GERALD H. TELETZKE, PH.D., DIRECTOR

December 10, 1987

Mr. Tadahiko Ono
Colonel, Corps of Engineers
Water Resources Branch
P. O. Box 2711
Los Angeles, California 90053

Dear Sir:

Thank you for the opportunity to comment on the "Draft Feasibility Report and Draft Environmental Assessment for the proposed Nogales Wash and Tributaries Nogales, Arizona" (Arizona State Clearinghouse #87800059).

Construction activities in stream beds should be conducted in compliance with the States "Policy on Construction and Related Activities in Water" (copy attached).

Dangerous biological contaminants have been documented in Nogales Wash near the International Boundary. Any downstream recreational developments should address potential pathways for waterborne and vectorborne disease transmission.

If you have any question on these comments, please contact Ed Swanson at 392-40443.

Sincerely,

A handwritten signature in cursive script that reads "Susan Monroe".

Susan Monroe, Planner
Office of Planning &
Program Development

cc: Arizona State Clearinghouse
Ed Swanson

ADOPTED APRIL 13, 1977 BY THE
WATER QUALITY CONTROL COUNCIL

ARIZONA DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL HEALTH SERVICES
BUREAU OF WATER QUALITY CONTROL

POLICY ON
CONSTRUCTION AND RELATED ACTIVITIES IN WATER

Appropriate items as listed below should be included in specifications for construction and related activities in waterways. Adherence to the cited procedures should assure compliance with Water Quality Standards for Surface Waters, R9-21. Specifications should require the person responsible for the activity to submit a program for effective control of water pollution to the person in charge of the project which includes procedures for protecting water from pollution with fuels, oils, bitumens, calcium chloride and other harmful materials, and for conducting and scheduling operations so as to avoid or minimize muddying and silting of the water.

Specific procedures for preventing water pollution may include:

1. Provision for temporary pollution control measures including dikes, basins, ditches and application of straw and seed.
2. Erosion control measures including minimizing clearing and grubbing and limiting exposure of erodible surface to 750,000 square feet for each location.
3. Construction of footings in water by sheet pile cofferdam method and pumping water from within the dam to settling ponds before returning it to the water.
4. Isolation of the construction area by sand dikes.
5. Erection of barriers, covers, shields and other protective devices as necessary to prevent any construction materials, equipment or contaminants from falling or being thrown into the water.
6. Construction of drainage facilities to control erosion and sedimentation.
7. Provision of an adequate means, such as a bypass channel, to carry a stream free from mud and silt around operations to remove material from beneath a flowing stream.
8. A requirement for transportation of materials across live streams to be conducted without muddying the stream, mechanized equipment should not be operated in stream channels of live streams except as may be necessary to construct crossings or barriers and fills at channel changes.

POLICY ON CONSTRUCTION AND RELATED ACTIVITIES IN WATER

Page 2

9. A requirement for wash water from aggregate washing or other operations containing mud or silt to be treated by filtration or retention in a settling pond, or ponds, adequate to prevent muddy water from entering live streams.
10. A requirement for oily or greasy substances originating from the contractor's operations not be placed where they will later enter a live stream.
11. Provisions for Portland cement or fresh Portland cement concrete not to be allowed to enter flowing water of streams.
12. A requirement to return the flow of streams as nearly as possible to a meandering thread without creating a possible future bank erosion problem when operations are completed.
13. A requirement that material derived from roadway work should not be deposited in a live stream channel where it could be washed away by high stream flows.

The person responsible for the activity should be required to monitor for turbidity every day in which there is a disturbance of the bed of the waterway. Monitoring should be performed not greater than one and one-half miles downstream from the construction or related operations and weekly reports of turbidity measurements should be reported to the water quality control agency.

4/13/77



Arizona Department of Water Resources

Engineering Division
2702 N. 3rd Street, Suite 2010
Phoenix, Arizona 85004
(602) 255-1541

Evan Mecham, Governor
Alan P. Kleinman, Director

December 30, 1987

District Engineer
Engineer U.S. Army Corps of Engineers
Mr. Paul Blakey, Water Resource Branch
Post Office Box 2711
Los Angeles, California 90053-2325

SUBJECT: Nogales Wash Draft Feasibility Report and
Environmental Assessment

Dear Mr. Blakey:

Thank you for the opportunity to review the subject report and assessment. The following comments are offered after careful review of both the feasibility report and environmental assessment by my staff:

In chapter 2; "Resources and Economy of the Study Area", I was surprised to see no mention of the economic effects of the devaluation of the Peso. This devaluation has had tremendous economic effects on all border communities.

In chapter 3; "Problem Identification and Opportunities", water quality issues did not indicate that contamination of the groundwater by TCE (and other volatile organics) has been found at the C. G. Conn's waste pond which is adjacent to Nogales Wash.

In chapter 4; "Plan Formulation", the report states that expected flood levels are less than floor elevations at produce warehouses in the Valle Verde area, thus damages would be minimal. This is true, but access to the docks would be restricted after the flood due to sediment deposits which would have to be removed prior to resumption of normal operations.

In the same chapter, the description of the proposed flood warning system is unclear and seems incomplete; repeaters are mentioned but locations are not shown on map(s); since repeaters are mentioned, one could assume the system will be radio telemetered, yet satellite telemetry is called for without addressing channel assignment and licensing; some locations of stream gauges and precipitation gauges could be improved; siren on the upper Potrero Creek gauge will not be heard by anyone if located where proposed.

If satellite telemetry is to be used there is no need for

be a need for one or more repeaters because of line-of-sight requirements. The "Base Station" or "Receive Site" will require the mentioned microcomputer but will also require appropriate software, receive antenna and cable.

The one hour lead time seems unlikely for some of the tributary locations.

The O&M costs associated with the flood warning system seem about three times too high. A reasonable rule of thumb is about 10% of the initial capital investment.

The implementation of any flood warning system in Arizona should be closely coordinated through the Arizona Department of Water Resources and the National Weather Service in order to insure compatibility, non-interference with neighboring systems, promote data exchange, and fit into the State/Federal planned network of local flood warning systems.

In chapter 5; "Plan Tentatively Selected for Implementation", mention is made of an existing "Civil Defense System" which is supposed to interrogate the self-reporting sensors. Self-reporting sensors need no interrogation. Appropriate software is available for microcomputers to receive and assimilate data from sensors and formulate a flood forecast. A good "Response Plan" including evacuation plans is also needed and this may be the Civil Defense System mentioned in the report.

In the "Environmental Assessment", it seems like a very good idea (as called for in the assessment) to fence off from grazing the proposed riparian area along Poudre Creek.

Overall the report had very good graphics, is well organized and concisely written with great attention to detail. There are numerous typographic errors remaining in the manuscript. A wide spectrum of structural and non-structural alternatives was evaluated but no alternative considered improving the hydrologic response of watersheds.

Hydrologic response is highly influenced by watershed condition. Hydrologic regimes can be "restored" by direct watershed treatment methods and implementation of best land use practices. Relatively inexpensive methods of watershed restoration such as manipulation of vegetation, contour ripping, seeding, gully plugs and check dams can dramatically reduce peak flows by enhancing the on-site retention detention potential of the contributing land area. Such methods are relatively economical, in line with the natural system, improve water quality by enhancing natural recharge, lower sediment yields, upgrade land productivity, and have lower associated O&M costs.

Of course, watershed restoration methods would not be stand

7. Regarding Relocation at Chula Vista

Relocation at Chula Vista was analyzed as a potential alternative. This solution, however, was found not to be economically justified, and was dropped from further consideration by the Corps. It was also found that relocation was not a favored solution by a large number of residents who presently live in the Chula Vista/Pete Kitchen community.

8. Regarding Dewatering Near Chula Vista

The proposed Chula Vista intercept tunnel would be constructed of precast concrete and would incorporate a subsurface system. This subsurface system would relieve the structure of hydraulic pressure, however, it would not dewater a large surrounding area. The proposed plan would also incorporate a structure that would allow the flow of water to be directed around the intercept tunnel. This structure would be constructed of concrete and would be located near the intercept tunnel. The structure would be constructed of concrete and would be located near the intercept tunnel.



Arizona
State Land Department



TO: DANICE CUMMINS, DEPARTMENT OF COMMERCE
DATE: DECEMBER 14, 1967
FROM: ROBERT L. V. NT, JR., JR., JR.
DIVISION OF NATURAL RESOURCES
RE: A REQUEST FOR ASSISTANCE IN THE ACQUISITION OF LAND
FOR THE DEVELOPMENT OF A RECREATION AREA

Very truly yours,
[Signature]

APPENDIX B
DRAFT LOCAL COOPERATION AGREEMENT

The following draft Local Cooperation Agreement (LCA) demonstrates the type of information that will be required in the final LCA, which will be signed and put into effect prior to construction. This agreement may be modified one or more times before it is finalized by Santa Cruz County and the Federal Government. The final LCA will be utilized as a contract which will layout significant policy decisions on project scope, timing of implementation, cost sharing, and financing.

The following draft Local Cooperation Agreement (LCA) demonstrates the type of contract that will be required prior to the initiation of construction of the proposed project. The specific information contained within the LCA is based upon information available at this time. As such, it is likely that changes will be made prior to finalization. This draft document was prepared by the Corps of Engineers under current guidance for cost sharing procedures.

Specific dollar values indicated in Article VI - METHOD OF PAYMENT, are based upon current information, October 1987 price levels, and 8 5/8% amortization rate. The numbers in parentheses are at October 1986 price levels and 8 7/8 % amortization rate.

DRAFT LOCAL COOPERATION AGREEMENT

STRUCTURAL FLOOD CONTROL PROJECT

LOCAL COOPERATION AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
THE SANTA CRUZ COUNTY FLOOD CONTROL DISTRICT
FOR CONSTRUCTION OF THE
NOGALES WASH AND TRIBUTARIES FLOOD CONTROL PROJECT

THIS AGREEMENT, entered into this _____ day of _____, 1987, by and between the DEPARTMENT OF THE ARMY (hereinafter referred to as the "Government"), acting by and through the Assistant Secretary of the Army (Civil Works), and the Santa Cruz County Flood Control District (hereinafter referred to as "the local sponsor"), acting by and through Santa Cruz County Flood Control District.

WITNESSETH, THAT:

WHEREAS, the Nogales Wash and Tributaries project was authorized by the overall Gila River and Tributaries Study by the Flood Control Act of 1938 and, WHEREAS, the Water Resources Development Act of 1986, Public Law 99-661, specifies the cost-sharing requirements applicable to the Project; and

WHEREAS, the local sponsor has the authority and capability to furnish the cooperation hereinafter set forth and is willing to participate in project cost-sharing and financing in accordance with the terms of this Agreement;

NOW, THEREFORE, the parties agree as follows:

ARTICLE I - DEFINITIONS for purposes of this Agreement:

1. The term "project" shall mean Alternative 1 of the Feasibility Report and Environmental Assessment, Nogales Wash and Tributaries, Nogales, Arizona. This alternative provides for channel improvements at two locations. The first is the "lateral collector channel" located on the U.S. side of the International Boundary. This channel would capture overland flow originating in Mexico and transition it into two existing, but unfilled covered channels. The second channels system, located at Chula Vista would capture breakouts of Nogales Wash and Potrero Creek and carry the flood flows around the community in a new 330 foot long grouted stone/concrete channel. Mitigation measures to ensure no net loss of riparian habitat over the project life, will be incorporated into the Chula Vista portion of the plan. Landscaping and aesthetic treatment along the channel will be used to satisfy a portion of the mitigation requirements. The Recommended Plan also includes a Flood Warning System that would reduce both flood damages and the threat to human life, and a small recreation component associated with the Chula Vista Channels.

2. The term "total project costs" shall mean all costs incurred by the local sponsor and the Government directly related to construction of the project. Such costs shall include, but not necessarily be limited to, actual construction costs, costs of applicable engineering and design, continuing

planning and engineering costs incurred after October 1, 1985, supervision and administration costs, costs of project construction contract dispute settlements or awards, and the value of lands, easements, rights-of-way, relocations, and dredged material disposal areas provided for the project by the local sponsor, but shall not include any costs for betterments or operation and maintenance.

3. The term "period of construction" shall mean the time from the advertisement of the first construction contract to the time of acceptance of the project by the Contracting Officer.

4. The term "Contracting Officer" shall mean the Commander of the U.S. Army Engineer District, Los Angeles, or his designee.

5. The term "highway" shall mean any highway, thoroughfare, roadway, street, or other public or private road or way.

ARTICLE II - OBLIGATIONS OF THE PARTIES

a. The Government, subject to and using funds provided by the local sponsor and appropriated by the Congress, shall expeditiously construct the project (including alterations or relocations of railroad bridges), applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The local sponsor shall be afforded the opportunity to review and comment on all contracts, including relevant plans and specifications, prior to the issuance of invitations for bids. The local sponsor also shall be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. The Government will consider the views of the local sponsor, but award of the contracts and performance of the work thereunder shall be exclusively within the control of the Government.

b. Upon completion of the project, or separable element thereof, the Government shall turn the completed element or project over to the local sponsor, which shall be solely responsible for operating, maintaining, and rehabilitating the project in accordance with Article VIII hereof.

c. As further specified in Article VI hereof, the local sponsor shall provide, during the period of construction, a cash contribution of 5 percent of total project costs.

d. As further specified in Article III hereof, the local sponsor shall provide all lands, easements, rights-of-way, and dredged material disposal areas, and perform all relocations and alterations of buildings, utilities, highways, railroads, bridges (other than railroad bridges), sewers, and related and special facilities determined by the Government to be necessary for construction of the project.

e. If the value of the contributions provided under paragraphs c. and d. of this Article represents less than 25 percent of total project costs, the local sponsor shall provide during the period of construction an additional cash contribution in the amount necessary to make its total contribution equal to 25 percent of total project costs.

f. No less than once each year the local sponsor shall inform affected interests of the limitations of the protection afforded by the project.

g. The local sponsor shall publicize floodplain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project.

ARTICLE III - LANDS, FACILITIES, AND RELOCATION ASSISTANCE

a. Prior to the advertisement of any construction contract, the local sponsor shall furnish to the Government all lands, easements, and rights-of-way, including suitable borrow and dredged material disposal areas, as may be determined by the Government to be necessary for construction of the project, and shall furnish to the Government evidence supporting the local sponsor's legal authority to grant rights-of-entry to such lands.

b. The local sponsor shall provide or pay to the Government the full cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged material disposal areas necessary for construction of the project.

c. Upon notification from the Government, the local sponsor shall accomplish or arrange for accomplishment at no cost to the Government of all alterations and relocations of buildings, highways, railroads, bridges (other than railroad bridges), storm drains, utilities, cemeteries, and other facilities, structures, and improvements determined by the Government to be necessary for construction of the project.

d. The local sponsor shall comply with the applicable provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved January 2, 1971, in acquiring lands, easements, and rights-of-way for construction and subsequent operation and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

ARTICLE IV - VALUE OF LANDS AND FACILITIES

a. The value of the lands, easements, and rights-of-way to be included in total project costs and credited toward the local sponsor's share of total project costs will be determined in accordance with the following procedures:

1. If the lands, easements, or rights-of-way are owned by the local sponsor as of the date this Agreement is signed, the credit shall be the fair market value of the interest at the time such interest is made available to the Government for construction of the Project. The fair market value shall be determined by an appraisal, to be obtained by the local sponsor, which has been prepared by an independent and qualified appraiser who is acceptable to both the local sponsor and the Government. The appraisal shall be reviewed and approved by the Government.

2. If the lands, easements, or rights-of-way are to be acquired by the local sponsor after the date this Agreement is signed, the credit shall be the fair market value of the interest at the time such interest is made available to the Government for construction of the project. The fair market value shall be determined as specified in subparagraph 1. above. If the local sponsor pays an amount in excess of the appraised fair market value, it may be entitled to a credit for the excess if the local sponsor has secured prior written approval from the Government of its offer to purchase such interest.

3. If the local sponsor acquires more lands, easements, or rights-of-way than are necessary for project purposes, as determined by the Government, then only the value of such portions of those acquisitions as are necessary for project purposes shall be included in total project costs and credited to the local sponsor's share.

4. Credit for lands, easements, and rights-of-way in the case of involuntary acquisitions which occur within a one-year period preceding the date this Agreement is signed or which occur after the date this Agreement is signed will be based on court awards, or on stipulated settlements that have received prior Government approval.

5. For lands, easements, or rights-of-way acquired by the local sponsor within a five-year period preceding the date this agreement is signed, or any time after this agreement is signed, credits provided under this paragraph will also include the actual incidental cost of acquiring the interest, e.g., closing and title costs, appraisal costs, survey costs, attorney's fees, plat maps, and mapping costs, as well as the actual amounts expended for any relocation assistance provided in accordance with the obligations under this Agreement.

6. The costs of relocations or modifications of utilities or facilities that will be included in total project costs and credited towards the local sponsor's share of total project costs shall be that portion of the actual costs incurred by the local sponsor as set forth below:

1. Highways and Highway Bridges: Only that portion of the cost as would be necessary to construct substitute bridges and highways to the design standard that the State of Arizona would use in constructing a new bridge or highway under similar conditions of geography and traffic loads.

2. Utilities and Facilities (Including Railroads): Actual relocation costs, less depreciation, less salvage value, plus the cost of removal, less the cost of betterments. With respect to betterments, new materials shall not be used in any relocation or alteration if materials of value and usability equal to those in the existing facility are available or can be obtained as salvage from the existing facility or otherwise, unless the provision of new material is more economical. If, despite the availability of used material, new material is used, where the use of such new material represents an additional cost, such cost will not be included in total project costs.

ARTICLE V - CONSTRUCTION PHASING AND MANAGEMENT

a. To provide for consistent and effective communication between the local sponsor and the Government during the term of construction, the local sponsor

and the Government shall appoint representatives to coordinate on scheduling, plans, specifications, modifications, contract costs, and other matters relating to construction of the project.

b. The representatives appointed above shall meet as necessary during the term of project construction and shall make such recommendations as they deem warranted to the Contracting Officer.

c. The Contracting Officer shall consider the recommendations of the representatives in all matters relating to the project, but the Contracting Officer, having ultimate responsibility for construction of the project, has complete discretion to accept, reject, or modify the recommendations.

ARTICLE VI - METHOD OF PAYMENT

a. The local sponsor shall provide, over the term of construction, the amounts required under Article II.c. and II.e. of this Agreement. Total project costs are presently estimated to be \$6,152,600 (\$6,022,600). In order to meet its share, the local sponsor must provide a total cash contribution presently estimated to be \$1,359,200 (\$1,328,400).

b. The required cash contribution shall be provided as follows: At least 30 days prior to the award of the first construction contract, the Government shall notify the local sponsor of its estimated share of project costs. Within 15 days thereafter, the local sponsor shall provide the Government the full amount of the required contribution by delivering a check payable to "FAO, USAED, _____" to the Contracting Officer representing the Government. In the event that total project costs are expected to exceed the estimate given at the outset of construction, the Government shall immediately notify the local sponsor of the additional contribution it will be required to make to meet its share of the revised estimate. Within _____ days thereafter, the local sponsor shall provide the Government the full amount of the additional required contribution.]

c. The Government will draw on the escrow account provided by the local sponsor such sums as it deems necessary to cover contractual and in-house fiscal obligations attributable to the project as they are incurred, as well as project costs incurred by the Government prior to the initiation of construction.

d. Upon completion of the project and resolution of all relevant contract claims and appeals, the Government shall compute the total project costs and tender to the local sponsor a final accounting of its share of project costs. In the event the total contribution by the local sponsor is less than its minimum required share of project costs at the time of the final accounting, the local sponsor shall, within 90 calendar days after receipt of written notice, make a cash payment to the Government of whatever sum is required to meet its minimum required share of project costs. In the event the local sponsor has made cash contributions in excess of 5 percent of total project costs which result in the local sponsor's having provided more than its required share of project costs, the Government shall within 90 days of the final accounting, subject to the availability of appropriations, return said excess to the local sponsor; however, the local sponsor shall not be entitled to any refund of the 5 percent cash contribution required pursuant to Article

II.c. hereof. If the local sponsor's total contribution under this Agreement (including lands, easements, rights-of-way, relocations, and dredged material disposal areas provided by the local sponsor) exceeds 50 percent of total project costs, the Government shall, subject to the availability of appropriations, refund the excess to the local sponsor within 90 days of the final accounting.

ARTICLE VII - DISPUTES

Before any party to this Agreement may bring suit in any court concerning an issue relating to this Agreement, such party must first seek in good faith to resolve the issue through negotiation or other forms of nonbinding alternative dispute resolution mutually acceptable to the parties.

ARTICLE VIII - OPERATION, MAINTENANCE, AND REHABILITATION

a. The local sponsor shall operate, maintain, replace, and rehabilitate the project upon completion in accordance with regulations or directions prescribed by the Government.

b. The local sponsor hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon land which it owns or controls for access to the Project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, repairing, maintaining, replacing, or rehabilitating the project. If an inspection shows that the local sponsor for any reason is failing to fulfill its obligations under this Agreement without receiving prior written approval from the Government, the Government will send a written notice to the local sponsor. If the local sponsor persists in such failure for 30 calendar days after receipt of the notice, then the Government shall have a right to enter, at reasonable times and in a reasonable manner, upon lands the local sponsor owns or controls for access to the project for the purpose of completing, operating, repairing, maintaining, replacing, or rehabilitating the project. No completion, operation, repair, maintenance, replacement, or rehabilitation by the Government shall operate to relieve the local sponsor of responsibility to meet its obligations as set forth in this Agreement, or to preclude the Government from pursuing any other remedy at law or equity to assure faithful performance pursuant to this Agreement.

ARTICLE IX - RELEASE OF CLAIMS

The local sponsor shall hold and save the Government free from all damages arising from the construction, operation, and maintenance of the project, except for damages due to the fault or negligence of the Government or its contractors.

ARTICLE X - MAINTENANCE OF RECORDS

The Government and the local sponsor shall keep books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to this Agreement to the extent and in such detail as will properly reflect total project costs. The Government and the local sponsor shall maintain such books, records, documents, and other evidence for a minimum of three years after completion of construction of the project and resolution of all claims arising

therefrom, and shall make available at their offices at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the parties to this Agreement.

ARTICLE XI - FEDERAL AND STATE LAWS

In acting under its rights and obligations hereunder, the local sponsor agrees to comply with all applicable Federal and state laws and regulations, including section 601 of Title VI of the Civil Rights Act of 1964 (Public Law 88-352) and Department of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army."

ARTICLE XII - RELATIONSHIP OF PARTIES

The parties to this Agreement act in an independent capacity in the performance of their respective functions under this Agreement, and neither party is to be considered the officer, agent, or employee of the other.

ARTICLE XIII - OFFICIALS NOT TO BENEFIT

No member of or delegate to the Congress, or resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom.

ARTICLE XIV - COVENANT AGAINST CONTINGENT FEES

The local sponsor warrants that no person or selling agency has been employed or retained to solicit or secure this Agreement upon agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the local sponsor for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this Agreement without liability, or, in its discretion, to add to the Agreement or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE XV - TERMINATION OR SUSPENSION

a. If at any time the local sponsor fails to make the payments required under this Agreement, the Secretary of the Army shall terminate or suspend work on the project until the local sponsor is no longer in arrears, unless the Secretary determines that continuation of work on the project is in the interest of the United States. Any delinquent payment shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to 150 per centum of the average bond equivalent rate of the 13-week Treasury bills auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3-month period if the period of delinquency exceeds 3 months.

b. If the Government fails to receive annual appropriations in amounts sufficient to meet project expenditures for the then-current or upcoming fiscal year, the Government shall so notify the local sponsor. After 60 days either

party may elect without penalty to terminate this Agreement or to suspend performance thereunder, and the parties shall conclude their activities relating to the project and proceed to a final accounting in accordance with Article VI.

[THE FOLLOWING ARTICLE MAY BE INCLUDED ONLY WHEN A LOCAL SPONSOR IS PROHIBITED BY THE RELEVANT STATE'S CONSTITUTION OR STATUTES FROM OBLIGATING FUTURE STATE LEGISLATURES TO APPROPRIATE FUNDS:

ARTICLE XVI - OBLIGATION OF FUTURE APPROPRIATIONS

Nothing herein shall constitute, or be deemed to constitute, an obligation of future appropriations by the legislature of the State of Arizona.

ARTICLE XVII - NOTICES

a. All notices, requests, demands, and other communications required or permitted to be given under this Agreement shall be deemed to have been duly given if in writing and delivered personally, given by prepaid telegram, or mailed by first-class (postage-prepaid), registered, or certified mail, as follows:

If to the local sponsor: [ADDRESS]

If to the Government: [ADDRESS]

b. A party may change the address to which such communications are to be directed by giving written notice to the other in the manner provided in this section.

c. Any notice, request, demand, or other communication made pursuant to this Article shall be deemed to have been received by the addressee at such time as it is personally delivered or on the third business day after it is mailed, as the case may be.

ARTICLE XVIII - CONFIDENTIALITY

To the extent permitted by the law governing each party, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

THE DEPARTMENT OF THE ARMY

THE LOCAL SPONSOR

BY: _____
Assistant Secretary
of the Army-Civil Works

BY: _____

DATE: _____

DATE: _____

APPENDIX C
FINANCIAL/ABILITY TO PAY ANALYSIS

The following Financial/Ability to Pay Analysis was prepared for this report by Santa Cruz County at the request of the Corps.

SCHEDULE OF SOURCE AND USE OF FUNDS

FUND AVAILABLE FROM LOCAL SPONSOR DURING PROJECT CONSTRUCTION

	Beginning Balance	Disbursements	Balance
	Plus Amount Received	Amount Available	Plus Amount Received
Available for Project			
Construction			
Local Sponsor			
Federal Government			
State Government			
County Government			
City Government			
Other			
Total			
Operation and Maintenance			
Local Sponsor			
Federal Government			
State Government			
County Government			
City Government			
Other			
Total			
Total			

FINAL
ENVIRONMENTAL ASSESSMENT

Wetlands & Tributaries

Wetlands & Tributaries

Wetlands & Tributaries

Wetlands & Tributaries

Wetlands & Tributaries

Wetlands & Tributaries

Wetlands & Tributaries

FINDING OF NO SIGNIFICANT IMPACT

PROJECT NAME: Nogales Wash & Tributaries.

COUNTY, STATE: County of Santa Cruz, State of Arizona.

I have reviewed the enclosed environmental assessment (EA) for the subject project. The proposed project entails the construction of a flood control channel around the south and east sides of the Chula Vista/Pete Kitchen residential communities, two lateral collector channels at the International Border with Mexico, a flood warning system, and a recreation plan. Potentially significant resources that could be affected by the proposed project include:

1. Riparian habitat along Nogales Wash and Potrero Creek and at the excess fill disposal site.
2. Potential National Register-eligible cultural resource sites along the proposed Chula Vista Channel and Lateral Collector Channels.

I have considered possible impacts on these significant resources as discussed in the EA, and find that, with inclusion of the environmental commitments identified in the EA, there are no significant impacts resulting from the project. An environmental impact statement need not be prepared for this project. Environmental commitments discussed in the attached EA include:

1. Mitigation of lost riparian habitat values by: (1) Acquisition and habitat improvement of all portions of Potrero Creek downstream of the west end of the Chula Vista Channel and upstream of its confluence with Nogales Wash (excluding that section which is bounded on both sides by mobile homes in the Pete Kitchen residential community); (2) Securing from future development the small vegetated depression located just north of Chula Vista and west of Nogales Wash; and (3) Aesthetic treatment of the Chula Vista Channel right of way to ensure the future development of a riparian woodland.
2. Disposal of the excess fill material at the 50-acre disposal site located north of Chula Vista will take place without the removal of any trees or other riparian vegetation. The fill material will not be placed so as to cover existing riparian vegetation or seasonal ponds.
3. Agreement by the Corps to conduct subsurface testing along the Chula Vista Channel and Lateral Collector Channel for cultural resource sites and, if sites are found, to determine eligibility for National Register Status.

Impacts to National Register-eligible sites will be mitigated to insignificant levels as outlined in the Programmatic Agreement between the Corps and the Arizona State Historic Preservation Officer. Signing of the Programmatic Agreement will be accomplished prior to completion of the next study phase.

4. Aesthetic treatment of the Lateral Collector Channels at the border crossing facility.

4/1/88
DATE

Glen F. Wereni
TADAHIKO ONO
For Colonel, Corps of Engineers
District Engineer

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- D. Cultural Resources Programmatic Agreement.
- E. 404 (b)(1) Water Quality Evaluation.
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FINAL
ENVIRONMENTAL ASSESSMENT

Project Name: Nogales Wash & Tributaries.

Project Location: In and near the City of Nogales, Santa Cruz County, Arizona.

Local Sponsor: Santa Cruz County.




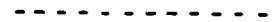
1. PROJECT LOCATION

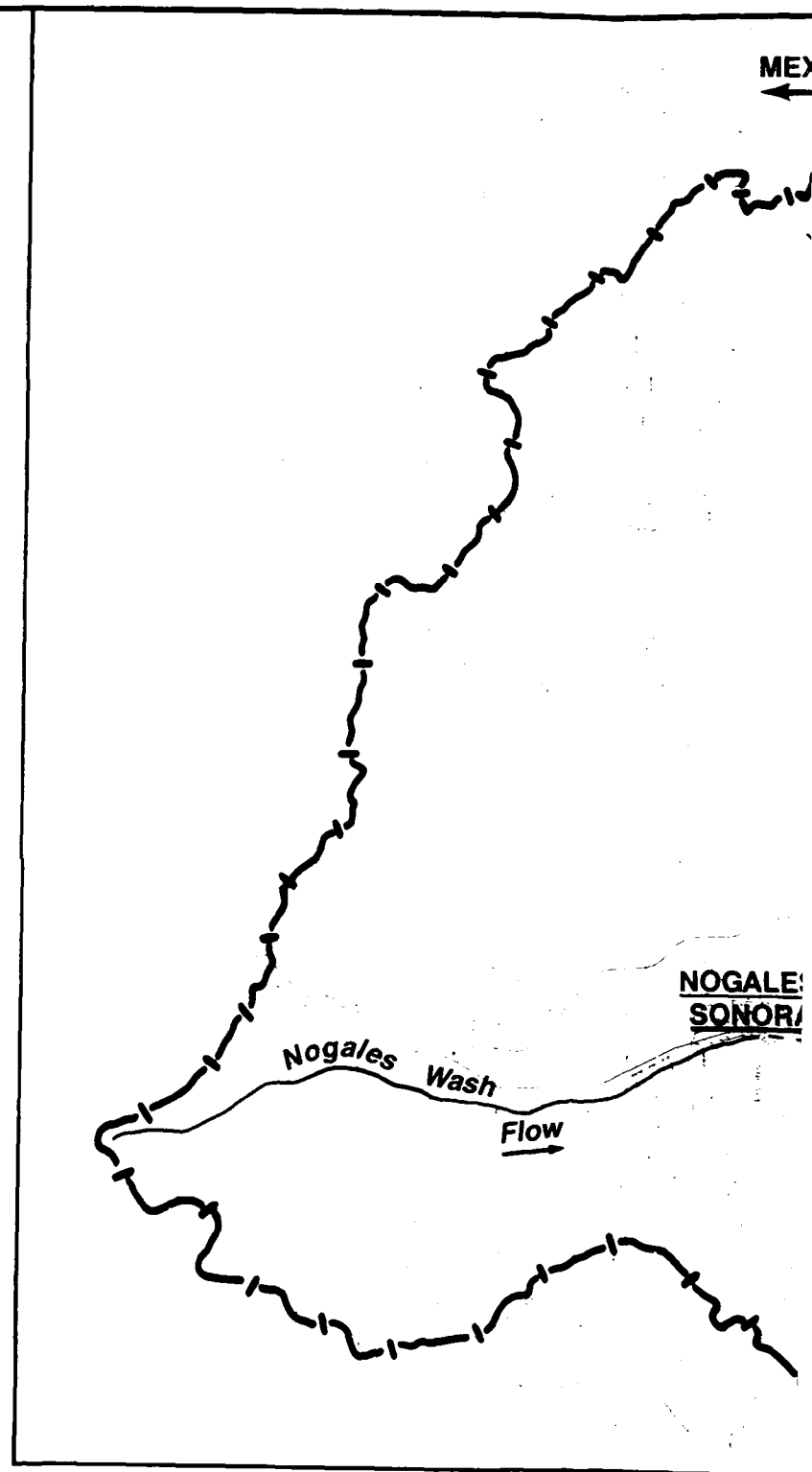
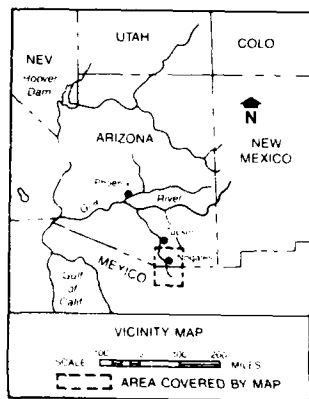
1-1. This project is located in the extreme southern portion of the state of Arizona. The County of Santa Cruz abuts Sonora, Mexico. Nogales Wash is located in the central and northern portions of the city of Nogales, Arizona, which is approximately sixty (60) miles south of Tucson. Potrero Creek and the downstream reaches of Nogales Wash are located in Santa Cruz County. Figure 1 shows the vicinity of the project area. Nogales Wash originates 7 miles south of the United States/Mexico International Boundary and flows north through Nogales, Sonora and Nogales, Arizona, joining Potrero Creek approximately 4.8 miles north of the border. Approximately 1 mile south of the border, Nogales Wash enters a covered channel referred to as the Nogales Wash Covered Channel (NWCC). The outlet from the NWCC is located approximately 0.9 miles north of the border near its confluence with the Arroyo Boulevard Covered Channel (ABCC). The ABCC is a similar conduit draining the metropolitan area of Nogales, Sonora. Approximately 0.9 miles north of the border, both covered channels open to form two open concrete channels. Several hundred feet further north, the two open channels converge to form a single channel. This channel, called the Nogales Wash Open Channel (NWOC) empties into the natural Nogales Wash streambed approximately 1.1 miles below the confluence of the NWCC and the ABCC. The remainder of Nogales Wash, about 1.7 miles, is semi-natural up to the Chula Vista subdivision where it enters Potrero Creek. Some areas have been straightened and modified with small stretches of gabions or concrete. Potrero Creek then flows for 3.9 miles beyond its confluence with Nogales Wash before flowing into the Santa Cruz River. The total drainage of Potrero Creek, including Nogales Wash, area is approximately ninety-four (94) square miles, 48% of which lies in Mexico.

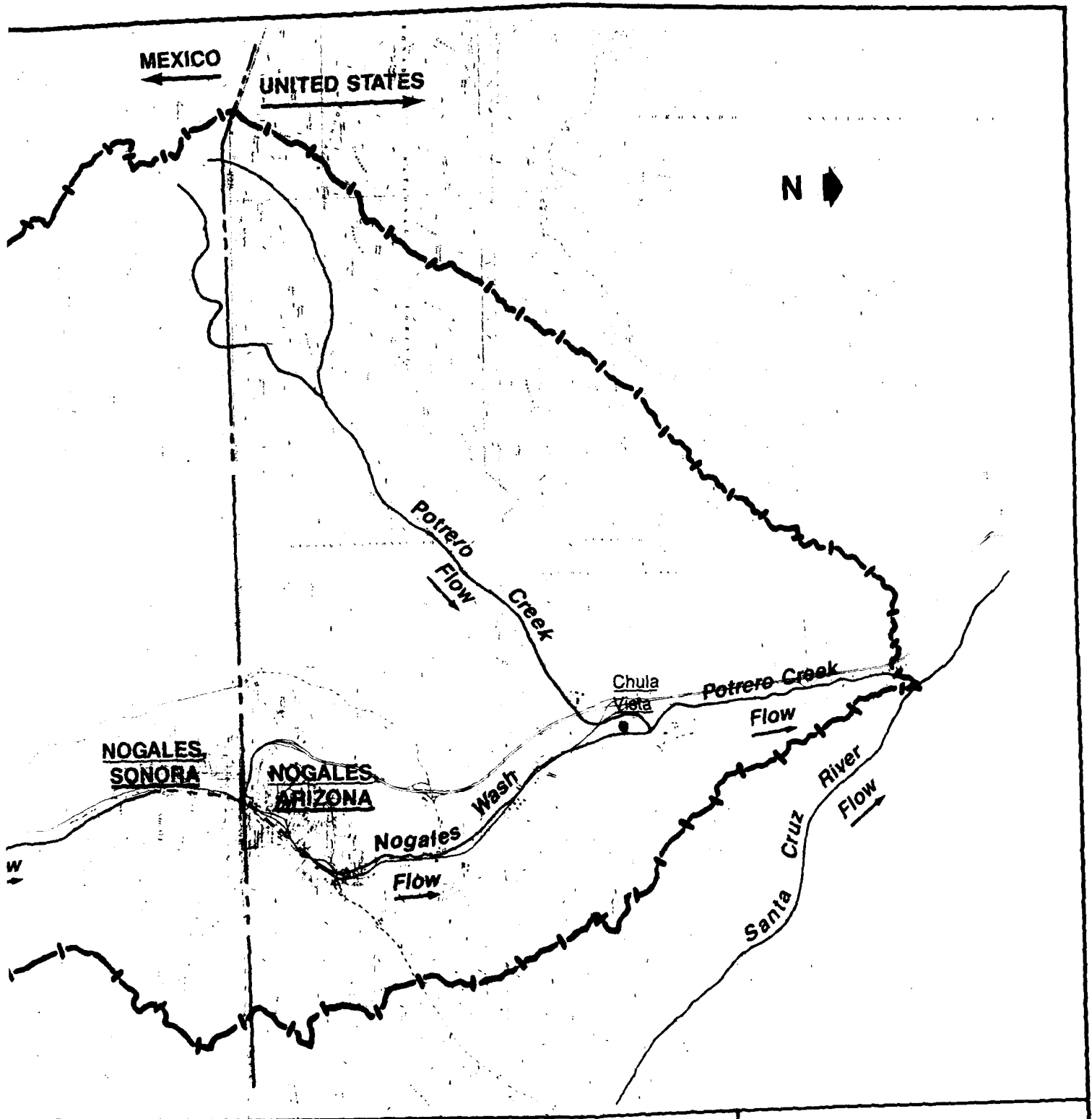
2. PROJECT BACKGROUND

2-1. The covered and open concrete channel portions of Nogales Wash which enter Nogales, Arizona from Mexico were constructed by the International Boundary and Water Commission (IBWC) during the 1930's. However, between 1970 and 1984, growth in Nogales, Arizona, increased by 93% while Nogales, Sonora, grew by 233%. This residential, commercial, and industrial growth within the Nogales Wash watershed has increased runoff by increasing the amount of impervious surface area. Much of the drainage that contributes flow to Nogales Wash is in Mexico. These circumstances have contributed to the current flooding problem along Nogales Wash and Potrero Creek.

LEGEND

-  Nogales Wash
Study Area/Drainage
Basin Boundary
-  International Boundary
-  Open Water Course
-  Covered Water Course





0' 4000' 8000' 16000'
Scale: 1" = 8,000'0"

Figure EA - 1
NOGALES WASH/POTRERO CREEK
STUDY AREA

3. NEED FOR PROPOSED ACTION

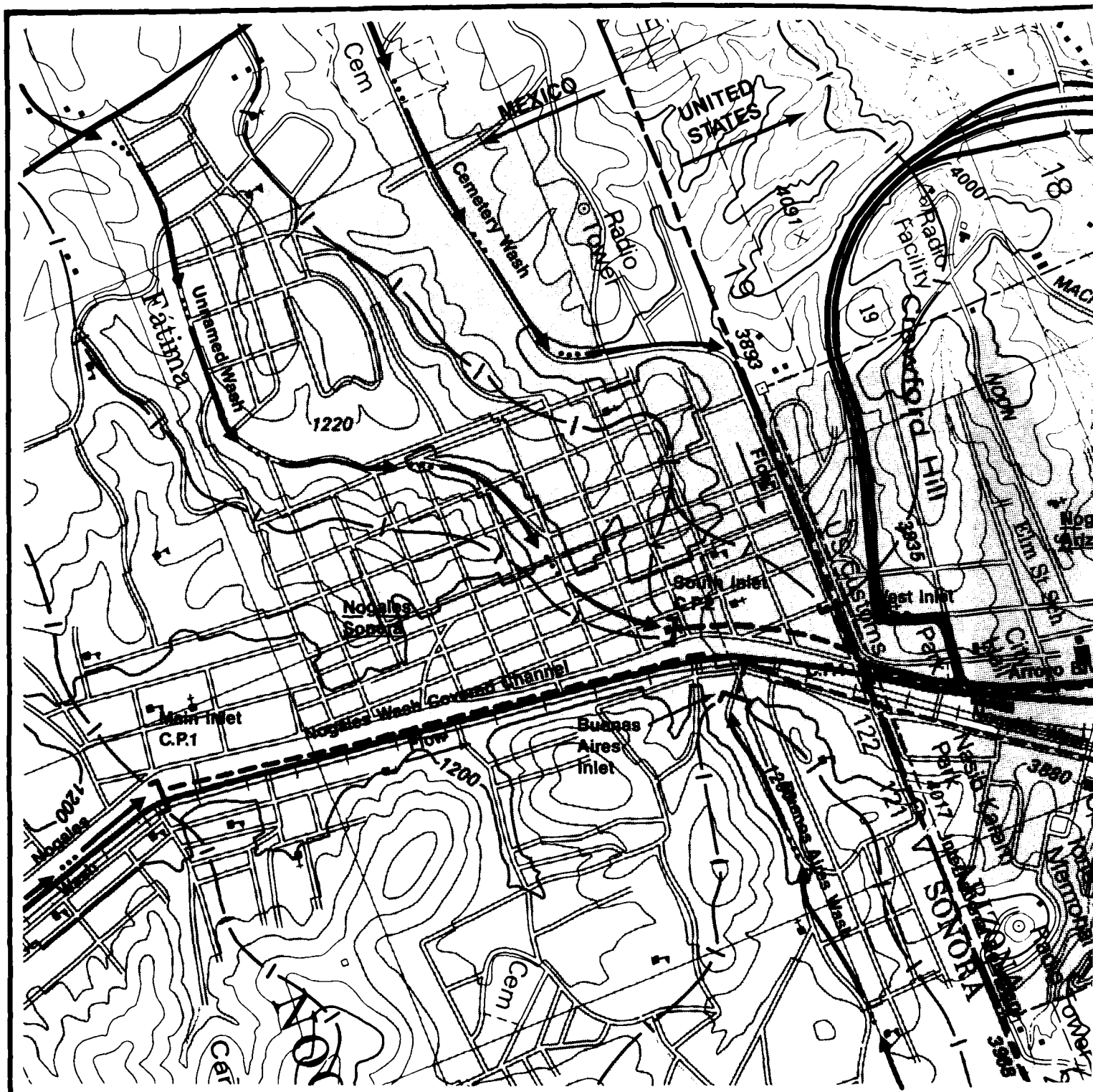
3-1. Major flooding events have been reported in 1905, 1909, 1914, 1915, 1926, 1930, 1931, 1977, 1978, 1980, and 1983. The city of Nogales and Santa Cruz County were among areas declared Presidential disaster areas in 1977 and 1978. Flood control protection is needed in the city of Nogales, Arizona at primarily two locations. At the international border with Mexico, overland sheet flow crosses downslope from Nogales, Sonora to Nogales, Arizona. Most of the flows are concentrated near the border crossing facility. These flows travel down through the downtown area of Nogales, Arizona until they find their way back into Nogales Wash. However, for its first 0.9 mile into the United States, Nogales Wash exists as two covered channels (figure 2). The overland flows return to the open concrete channel. Hence, these overland flows are forced to traverse city streets for at least a distance of 0.9 miles. Another location in need of flood protection is the Chula Vista subdivision and adjacent Pete Kitchen mobile home park. These adjacent communities (hereafter referred to as the Chula Vista community) are located between and just upstream of the confluence of these two creeks. Floodflows overtop the banks of both creeks then flow through these communities on a yearly basis.

4. PROPOSED ACTION

4-1. Project Description: The proposed action, referred to as Alternative #1, entails the following five components: (1) The Lateral Collector Channels (LCC) at the international border; (2) The Chula Vista Channel (CVC); (3) The disposal area for the excess fill; (4) The Flood Warning System; and (5) The Recreation Plan.

4-2. The two Lateral Collector Channels are entrenched concrete channels placed adjacent and parallel to the international border on the United States side (figure 3). The eastern one (4 ft. wide by 484 ft long) will capture overland flow and direct it westward back into the existing NWCC through a 59-foot long and 48-inch diameter reinforced concrete pipe with flap gates. Unused capacity exists in the NWCC during flood events due to inadequate and unmaintained inlet structures in Mexico. The western LCC (30 inches wide by 162 ft long) will also capture overland flow, but direct it toward both of the existing covered channels (NWCC and ABCC) through concrete pipes with flap gates. The ABCC also has unused capacity during flood events. The eastern LCC will be a fenced open channel except for a 53 ft long section at the existing pedestrian crossing which will be grated. All of the western LCC will be grated.

4-3. The level of protection provided by the Lateral Collector Channels (LCC) will change over time due to increasing urbanization and changing watershed land use in both Mexico and the United States. Immediately after construction the level of protection ("present" level of protection) will be for a 44-year event. A 44-year flood event is of a magnitude that would be expected to reoccur, on average, no sooner than once every 44 years. The level of protection provided by the LCC's at the end of the project life (100 years), or the "future" level of protection, is expected to be sufficient for a 33-year event.

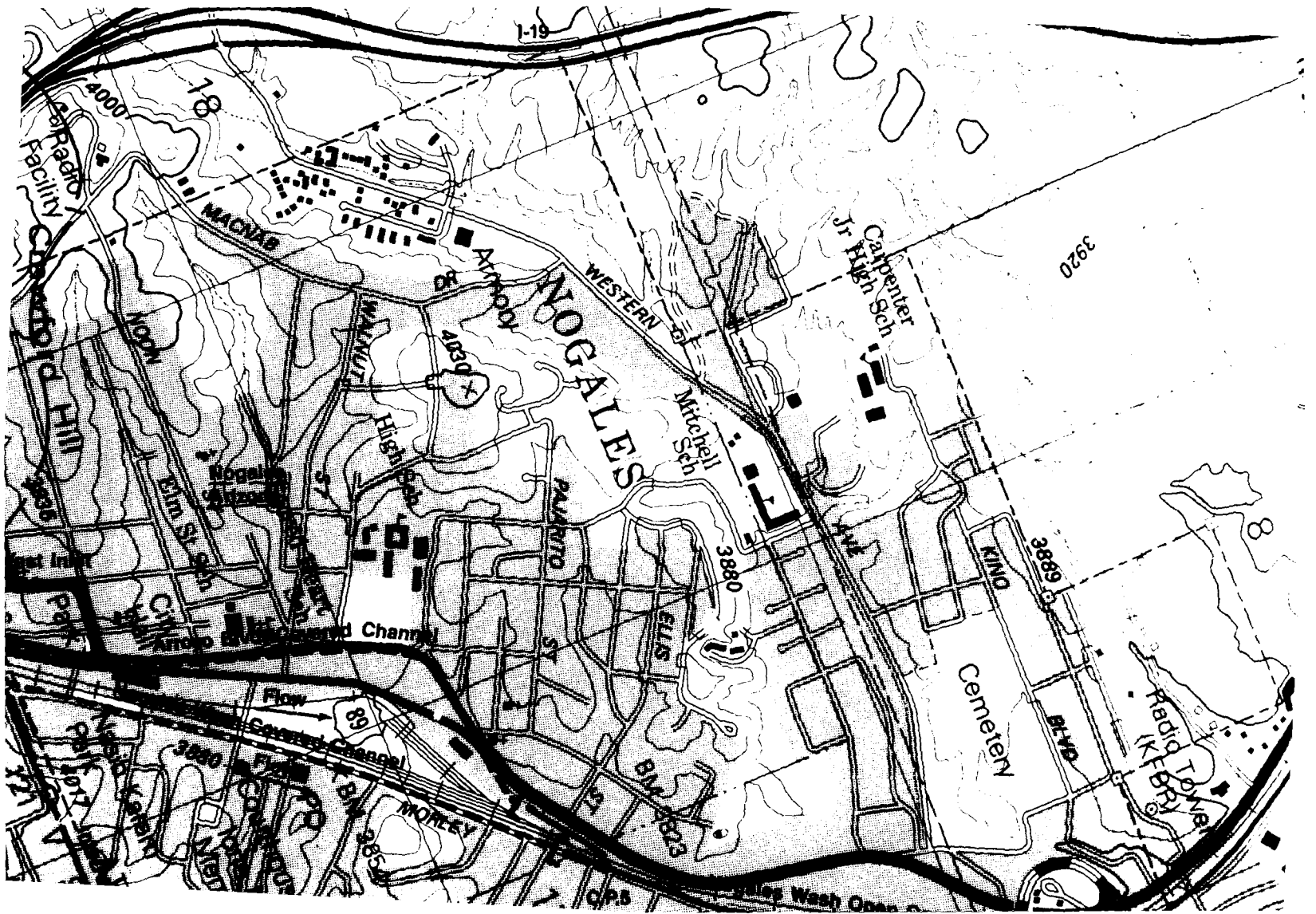


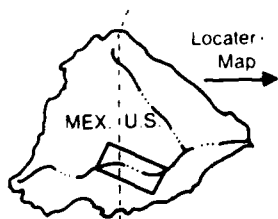
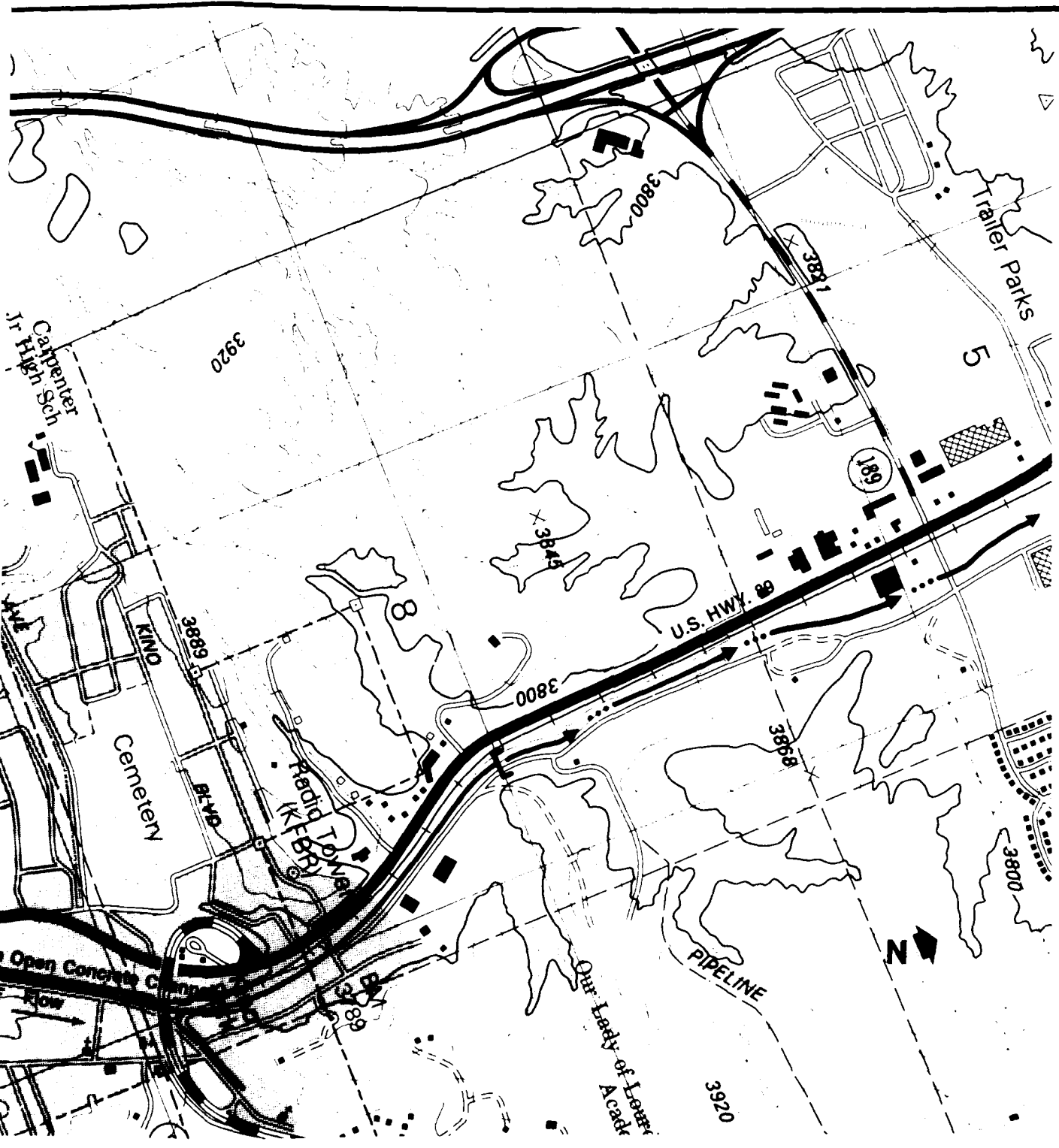
LEGEND

- |— Subarea Boundary
- International Boundary

- Covered Concrete Channel
- Open Concrete Channel
- > Channel Flow Upstream of Inlets and Downstream of Open Concrete Channel
-] Channel Inlets
- [----- Channel Outlets

CP# Concentration Point

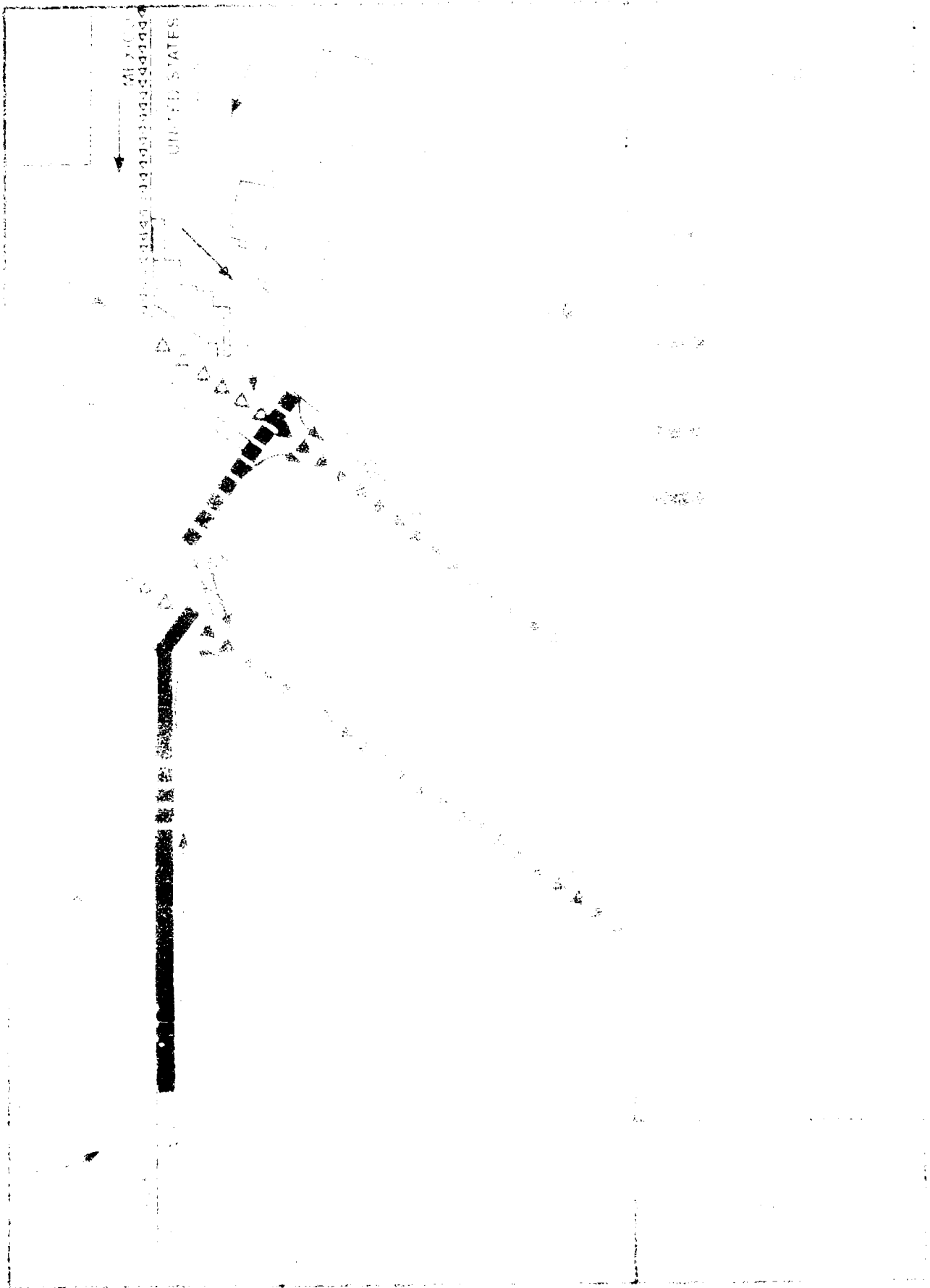




Locator
Map

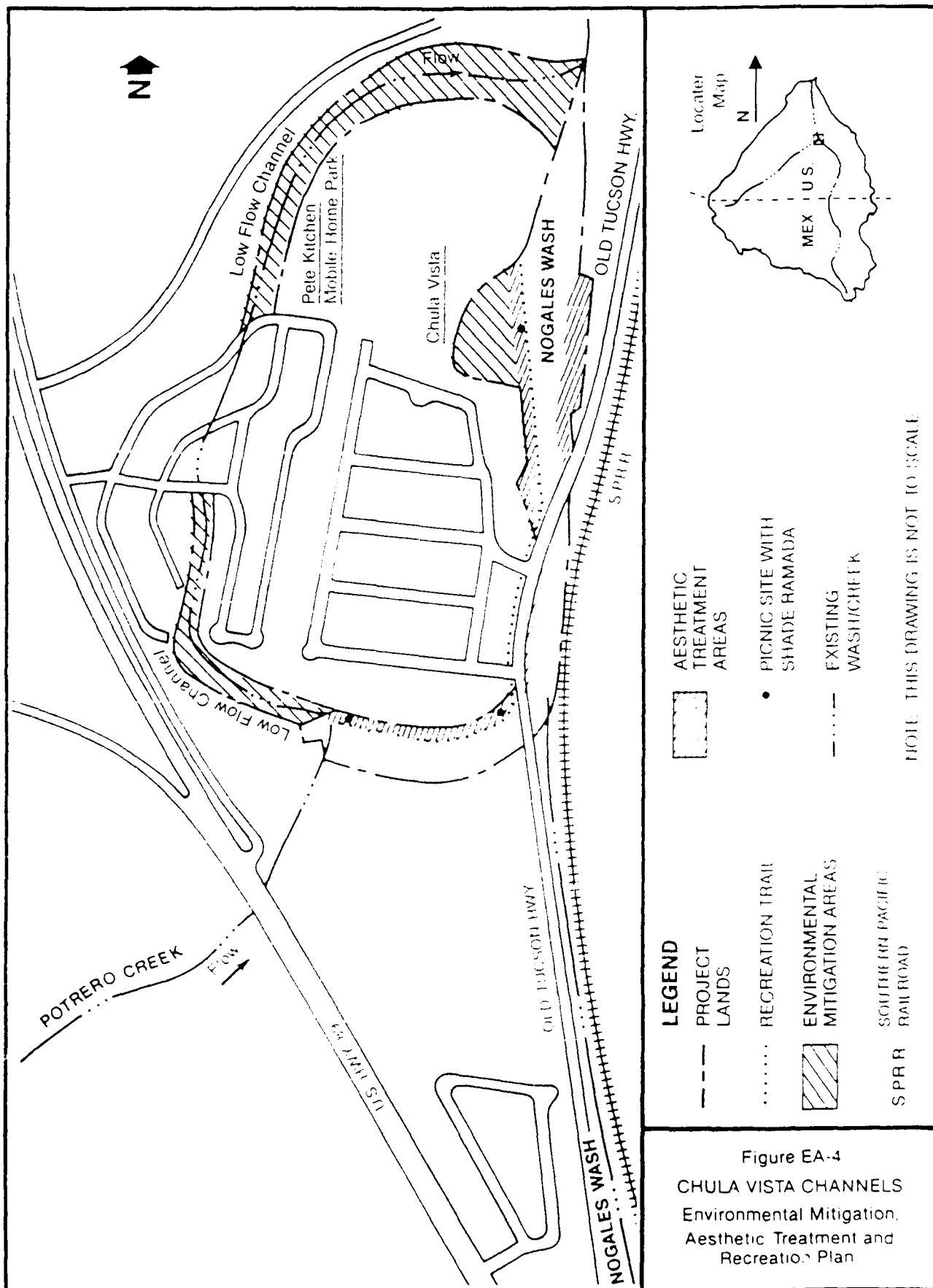
0' 500' 1000' 2000'
Scale 1" = 1000 ft.

Figure EA - 2
Nogales Wash
Existing Flood Control
Channel System



4-10. The Disposal Site for the anticipated 127,000 cubic yards of excess fill material remaining after construction is located at the intersection of the 150th Ave. and Potrero Creek approximately 2 miles downstream of the Vista. The site is 50 acres in size and is currently used as a horse ranch. The fill material will be placed to a depth of 1.6 feet, but will not be compacted. Further coordination with the land owner will be conducted during the next study phase to ensure that all disposal activities are acceptable to the land owner. Should the site or plan for disposal of excess fill material change during the next study phase, further NEPA documentation may be necessary.

2. The Depression Area. A densely vegetated area lies along the west side of the CVC Right of Way and adjacent to the north side of the Santa Anita Subdivision. This area is densely vegetated due to the excavation the past of a livestock watering area. A small levee surrounds the north side of this area. The depression is all water during the wet season and dries up during the dry season. The area is very fertile.



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outside of the project alignment and its ROW will be secured from future development by purchase of easements and will be fenced to exclude livestock.

3. CVC Right of Way Area. A normal feature of Corps flood control channels is aesthetic treatment to compensate for loss of aesthetic values normally associated with replacement of riparian corridors with concrete channels. Aesthetic treatment is planned for this alternative. As such, appropriate design of the aesthetic treatment along the CVC will also contribute to mitigation of the biological impacts of the project. The aesthetic treatment planned includes construction of a permanent sprinkler irrigation system along 2.5 acres of the CVC ROW (with the exception of the ROW on the south side of the CVC, where vegetation would interfere with the function of the diversion channel). The channel ROW will be planted with riparian species that will develop, over time, into Cottonwood-Willow and Mesquite woodland.

4. Lateral Collector Channels Aesthetic Treatment. Aesthetic treatment of the LCC's at the border crossing will mitigate the aesthetic impacts of construction a combined 500-foot long Lateral Collector Channel. The western LCC will be covered with a metal grate to allow pedestrians and surface flow to pass over it. In addition, the grating will be painted to reduce the visual impact. The eastern LCC is mostly uncovered. The aesthetic and potential public safety impacts will be mitigated by placing a 6-foot solar-coded chain link fence adjacent to and on the north side of the channel.

5. Excess Soil Disposal Area. Portions of the disposal area contain significant biological resources (Cottonwood-willow riparian habitat, Mesquite woodland, and seasonal ponds). Impacts to these resources will be avoided through disposal activities. No high quality vegetation will be removed or treated in this area. Other nearby land in the possession of the landowner may be found to be more suitable for disposal. During the next study phase, further coordination with the landowner will be conducted. Should the disposal site or methodology change significantly, further NEPA documentation will be prepared.

4-13. The responsibility is assignable for all plantings designed to improve habitat values in the Extreme Creek Mitigation Areas. The Corps will also be responsible for construction of the fence around the mitigation areas. The County of Santa Fe will be responsible for acquiring all mitigation lands. The County will also be responsible for any future maintenance of the irrigation systems. The vegetation of the mitigation lands will be designed such that no interference to the project will occur that the water supply is functional. The responsibility for the maintenance of the Extreme Creek and the irrigation system along the channel will, upon final disposition, responsibility will be to ensure that the integrity of the lands surrounding the mitigation lands is maintained. Aesthetic treatment at the border crossing facility will be accomplished by the Corps during construction and maintained by the County thereafter.

4-14. The riparian improvement along Potrero Creek will be accomplished by the

emplacement of dormant plant stock to be obtained from those portions of riparian wash to be lost to construction and possibly some seeding. The best time of year to obtain dormant stock is in the fall when the trees have stored up reserves for the upcoming winter and spring. Hence, the initiation of mitigation measures (collection of dormant riparian tree stocks) shall take place during the fall season immediately preceding the initiation of construction. The planting of the dormant stock will take place as soon as the stock is collected. Erection of the fence along both sides of the Potrero Creek mitigation area will take place as soon as the plantings are complete. Construction of the aesthetic treatment features in the CVC ROW will take place immediately after the CVC channel is constructed. The aesthetic treatments at the border crossing facility can take place at any time during construction of the project.

4-15. Previously Prepared NEPA Documents Pertinent to this Action: No previous NEPA documents are known for the project area. The Coronado National Forest recently prepared an Environmental Impact Statement for their 5-year forest plan (USDA, 1986). Although portions of the Coronado National Forest are located in Santa Cruz County, that EIS did not address environmental resources near the Chula Vista community nor at the border crossing area.

5. ALTERNATIVES

5-1. Alternative 2: Lower Level Protection: This alternative is very similar to the proposed project (Alternative #1) with the exception that rather than a CVC designed for a 100/125 level of protection, it will be designed for a 20/24 level of protection. As such, the 20/24 design would be generally of less width and depth than the 100/125 design. The biological impacts resulting from Alternative #2 CVC would be of slightly lower magnitude than for Alternative #1. The other components to this project would be identical to those described for Alternative #1.

5-2. The mitigation plan for this alternative would be similar to the mitigation plan described for Alternative #1. The differences would be: 1) Alternative #2 would not require acquisition of the Depression Area; 2) 1.3 acres, rather than 2.5 acres of the CVC ROW will be vegetated; and 3) 5.0 acres, rather than 5.5 acres, would be acquired and undergo habitat improvement along Potrero Creek (3.4 acres of which are located downstream of the Chula Vista Mobile Home Park). Appendix C discusses in more detail the differences for this alternative.

5-3. Alternative 3: Other Alternatives Eliminated Early in the Process: Santa Cruz County of Santa Cruz requested that the Corps evaluate a plan for Alternatives #1 and #2. Their plan was composed of five components: 1) a Collector Channel with a 100/133 level of protection; 2) a 2.5 acre wetland area with a 100/125 level of protection (same as Alt. #1); 3) a 1.3 acre wetland area (same as Alt. #1); and 4) a separate channel to protect the Valle Verde area upstream of the Chula Vista Community. The Valle Verde Channel would provide a 100/125 level of protection. This alternative was eliminated in the final stage of analysis due to the fact that portions of the alternative were not economically justified.

5-4. Another alternative was evaluated early in the study and was found to be

channelization of approximately 9 miles of Nogales Wash. However, that alternative was also found not to be economically justified. Significant environmental impacts were also expected to add significant mitigation costs to the project. This alternative was not taken to the final stage of analysis. The Main Report presents an in-depth discussion of an array of additional alternative measures that were considered during earlier phases of the study, but that were not taken to the final stage of analysis.

5-5. Alternative 4: No Action: This alternative would entail no Federal action to remedy the flooding problems of the study area. The County would be expected to continue pursuing limited flood protection projects as they have in the past (e.g., the soil cement placed along the west side of Nogales Wash as it crosses Old Tucson Road at the northeast corner of the Chula Vista subdivision). However, under the no action alternative, significant bank erosion rates along Nogales Wash would be expected to continue (see Plate 1).

6. EXISTING ENVIRONMENT

6-1. This section contains discussions of environmental resources within areas that would be affected by the proposed project and alternatives. The information presented in the description of the existing environment was obtained from a variety of sources. Field reconnaissance trips were taken in Sept. 1985, Oct. 1985, Dec. 1985, Mar. 1986, Feb. 1987, and Feb. 1988. These field trips often included representatives of other resource agencies such as the U.S. Fish and Wildlife Service (FWS) and the Arizona Dept. of Game and Fish (ADGF), as well as study team members from the Corps. On some of these trips, multi-agency scoping meetings were held to identify important issue areas. Other sources of information included reports prepared by the FWS (e.g. the FWS Planning Aid Letter, dated July 10, 1984 and the FWS Coordination Act Report, dated February 11, 1988), a bird survey of Nogales Wash contracted by the Corps, the Corps' July 1984 Environmental Evaluation of Nogales Wash, and various coordination letters from interested agencies.

Biological Resources:

6-2. The vegetation located in the vicinity of the Chula Vista Channel is of two primary types. Along the first half of the CVC (with the exception of the very beginning of the CVC) exists a grass covered pasture that is very heavily grazed by cattle. It appears that the vegetative biomass of the pasture is not permitted to increase sufficiently to provide a useful substrate for insects. Therefore, this area is of comparatively low value to wildlife. The lower half of the CVC alignment generally coincides with high quality desert riparian habitat. High quality desert riparian habitat is also found along some sections of Potrero Creek between its intersection with the west end of the CVC and its confluence with Nogales Wash. However, there are some non-vegetated portions along this reach of Potrero Creek. No vegetation exists in the vicinity of the Lateral Collector Channels as this area is heavily urbanized. Surveys of the disposal site found that the portion north of the Old Tucson Highway contains a dense cover of Mesquite. The portion south of the Highway contains some limited high quality riparian habitat and some seasonal spring fed ponds used by waterfowl. Other nearby areas owned by the same landowner have very little

biological value and may be more appropriate for disposal of excess fill.

6-3. In the vicinity of the Chula Vista Channel, wildlife values are closely associated with the riparian zone. The cover and water associated with riparian habitats attract wildlife from adjacent grasslands as well as supporting a diverse riparian fauna. Riparian habitat along Nogales Wash and Potrero Creek is composed of 4 types. The first is characterized by Mexican elderberry (Sambucus mexicana) in pure stands. This type is primarily found in the upstream reaches outside of the CVC project area. The second type is comprised of a mixture of species including Mexican elder, Mesquite (Prosopis sp.), and willow (Salix sp.). This type occurs sporadically throughout both Nogales Wash and Potrero Creek. The third type, composed of mesquite is found in the mid and lower reaches. In some places it forms a closed canopy bosque. The fourth type is cottonwood-willow, dominated by cottonwood (Populus fremonti).

6-4. The more structurally diverse cottonwood-willow community is the more important wildlife habitat due to the presence of a higher diversity of food and cover sources. Differences in vegetative heights, presence of tree boles, canopy cover, and other structural features enable more species to find cover and food resources. The relatively high wildlife value of the cottonwood-willow stands was demonstrated by the Corps-funded breeding bird survey conducted along Nogales Wash and Potrero Creek in 1986 (Groschupf, 1986). This study found that gallery cottonwood forests had the greatest number of different bird species (39 species) as compared to the other riparian cover types.

6-5. No surveys for mammals, reptiles, amphibians, or fish were conducted in the project area. However, based on data from other southern Arizona riparian areas, the U.S. Fish and Wildlife Service listed 16 non-bird and non-special status wildlife species that could be expected for the CVC project area (USFWS, 1987).

6-6. Threatened, Endangered, or Otherwise Sensitive Species: No federally listed threatened or endangered species occur in the project area (USFWS, 1987). It is possible that peregrine falcons (Falco peregrinus anatum) and bald eagles (Haliaeetus leucocephalus) may use the area during winter migrations. However, there is no clear evidence of historical use of the project area by these species. Other special status species possibly present in the area are displayed in Table 1.

Table 1 Special Status Species Possibly Present in Project Area.

<u>Species Name</u>	<u>Group</u>	<u>List</u>
Beardless Cinch Weed (<u>Pectis imberbis</u>)	Category 2 Candidate	Federal
Mexican Garter Snake (<u>Thamnophis eques</u>)	Group 3	State
Desert Hooknosed Snake (<u>Gyalopion quadrangulare</u>)	Group 3	State

Grey Hawk (<u>Buteo nitidus</u>)	Group 2	State
Northern Beardless Tyrannulet (<u>Campostoma imberbe ridgwavi</u>)	Group 3	State
Black-Bellied Whistling Duck (<u>Dendrocygna autumnalis fulgens</u>)	Group 4	State
Mountain Skink (<u>Eumeces callicephalus</u>)	Group 4	State
Plains Narrow-Mouthed Toad (<u>Gastrophryne olivacea</u>)	Group 4	State
Yaqui Black-Headed Snake (<u>Tantilla vaquia</u>)	No official Status	FWS concern
Western Yellow-Billed Cuckoo (<u>Coccyzus americanus occidentalis</u>)	Category 2 Candidate	Federal
Thick-Billed Kingbird (<u>Tyrannus crassirostris</u>)	Group 3	State
Rose-throated Becard (<u>Pachyramphus richmondi</u>) (<u>aglaiae</u>)	Group 3	State

Federal Category 2 Candidate Species = Those species that have been published in a Notice of Review in the Federal Register for which the FWS does not have sufficient information at this time to support their being listed as threatened or endangered.

State Group 3 = Those species for which the state of Arizona has determined that their continued presence in the state could be in jeopardy in the foreseeable future.

State Group 4 = Those species with moderate threats to their habitats which, if threats increased, would qualify for Group 3 status.

6-7. Cultural Resources: A combined literature search and intensive pedestrian survey of the proposed project area was performed under contract for the Corps by Statistical Research, Inc. This report is on file in Los Angeles District files. This study was designed to identify cultural resource sites along Nogales Wash between the international border and Potrero Creek and Potrero Creek between the confluence with Nogales Wash and the Santa Cruz River. The

diversion channel portion of the CVC was not surveyed. Based on the identification of a buried prehistoric site near the project right-of-way in Chula Vista, the project alignment is now believed more sensitive with respect to buried archeological resources than previously supposed. Because of the discovery of prehistoric cremations and a possible village site near the international border, a potential for buried sites also exists in this area. During the next project phase it will, therefore, be necessary to conduct subsurface testing for buried sites in selected areas of the project alignment. Additional testing may be required at a later date to evaluate the significance of sites identified during initial testing.

6-8. Land Use: The study area is devoted to commercial and industrial use with some residential use interspersed. In the area of the Lateral Collector Channels, land use is dominated exclusively by the urban setting of the downtown area and associated border crossing facility. Land use near the Chula Vista Channel is dominated by the residential communities of Chula Vista and Pete Kitchen. To the south and north and adjacent to the Chula Vista community lie two open lots used to graze livestock. Each lot is roughly 20 acres in size. The northern lot also contains a depression with a berm on one side. This depression serves as a water catchment for the livestock. Directly to the east of the north-south trending portion of the CVC lies railroad tracks owned by Southern Pacific Railroad. The land east of the railroad is hilly and used primarily for grazing. The 50-acre parcel to be used as the disposal site for the excess fill material straddles Old Tucson Road and is currently used for grazing and training horses.

6-9. Farmland Resources: No farmland resources exist in the vicinity of the LCC's as this area is heavily urbanized. The two open lots north and south of the Chula Vista community are considered Prime and Unique Farmlands by the Soil Conservation Service (see record of correspondence in Appendix A). Twenty-nine of the 50 acres at the disposal site are considered Prime and Unique Farmlands by SCS. As a whole, Santa Cruz County contains 47,048 acres of Prime Farmland according to the SCS.

6-10. Water Resources: The Santa Cruz River serves as the major drainage for the Nogales area. Based on an average annual precipitation of 15.5 inches, Santa Cruz County receives about 1,060,000 acre-feet of precipitation per year. Ninety-five percent of the water is lost through evapotranspiration. Currently, the Chula Vista community suffers flood damages on almost a yearly basis due to flows breaking out of the banks of Nogales Wash and/or Potrero Creek. The community is located in a low area near the confluence of Nogales Wash and Potrero Creek.

6-11. A very low percentage of the annual average 15.5 inches of precipitation throughout Santa Cruz County is available to recharge groundwater supplies. The County relies almost exclusively on groundwater (usually at a depth of less than 200 feet) for water supply. The Nogales area lies in the Calabasas-Nogales subarea where the water-bearing units are the Nogales Formation, and older and younger alluvium with the younger alluvium bearing most of the groundwater. Streamflow provides the principal source of groundwater recharge to the younger alluvium.

6-12. Groundwater levels in the vicinity of Nogales Wash vary. The Arizona Dept. of Water Resources, Hydrologic Map Series Report No. 11 (dated January, 1984) provides data for the nine wells pumping from the vicinity of Nogales Wash. Depth to groundwater varied between 10 and 35 feet (mean = 21.6 feet). However, According to the Corps Draft Feasibility Geotechnical Appendix (Sept., 1986) "Groundwater is at or near the proposed invert elevations throughout the study reach". Higher groundwater levels in the area of Chula Vista are not surprising insofar as this area coincides with the confluence (and common flood plain) of Nogales Wash and Potrero Creek.

6-13. Water Quality: Traditionally, there have been rather serious water quality problems existing at Nogales, Arizona, due to its relationship with Nogales, Sonora. With the population of Nogales, Sonora, exceeding 200,000, the problem of waste collection has posed a threat to the downstream flow across the International Border and into Nogales, Arizona. The International Boundary and Water Commission (IBWC) has been aware of this problem for years. Inadequate sewage collection facilities in Nogales, Sonora, result in the release of raw sewage (with its attendant fecal coliforms) which flows across the border via Nogales Wash. During flood events, pipe breaks result in even more sewage being released in Mexico which flows into Nogales, Arizona.

6-14. Air Quality: Nogales, Arizona, including the study area, is considered an attainment area. Although it does exceed the particulates standard, it is still considered an attainment area because it falls under the EPA rural fugitive dust policy which states that in the western states, those areas with no industrial facilities and populations of 50,000 to 100,000 would be considered as attainment areas (Arizona Dept of Health Services). The particulates problem is probably due to the nearness of Nogales, Sonora, which has unpaved roads and where wood burning is allowed. The vicinity of the LCC's also experiences carbon monoxide (CO) problems on occasion due to idling cars and trucks from Mexico. Most of the vehicles are very old and Mexico does not have the air quality laws that are comparable to those in the United States. CO is probably only a problem in the direct vicinity of the border crossing facility and is seasonal, occurring during the winter months.

6-15. Noise: The dominant noise sources adjacent to the Nogales Wash study area include: automobiles; trucks; motorcycles; emergency vehicles; and the railroad. Industrial noise consists of truck loaders at the many produce firms located adjacent to the Wash. Some heavy construction noise comes from bulldozers, cranes, jackhammers, etc. Within residential areas, light construction noise is produced by saws, hammers, etc. Noise levels in the vicinity of the LCC's comes primarily from the border crossing facility where many people and automobiles congregate. Noise sources close to the Chula Vista community includes Highway #89 and the Old Tucson Highway which lie adjacent to and on the west and east sides, respectively. Many large trucks use the Old Tucson Highway when travelling to or from the produce warehouses located along Nogales Wash. The Southern Pacific railroad (which lies parallel to and on the east side of Nogales Wash) also contributes noise to the Chula Vista community. There have been no ambient noise level studies conducted within the study area (Smith, 1984).

6-16. Transportation: Adjacent to Nogales Wash are two major thoroughfares. The Southern Pacific Railroad, for most of the upstream area through the City of Nogales, parallels the west bank of Nogales Wash. A crossover occurs before the city limits and from that point the tracks parallel the east bank of the Wash. State Highway 89 parallels the wash along the west bank through the city limits, and outside the city limits the wash parallels the Old Tucson Highway rather than the newer I-19 up to the waste water treatment facilities. There are 14 bridge crossings along the Nogales Wash study area, one of which is located along the CVC alignment near Chula Vista.

6-17. Nogales' proximity to Mexico makes it a natural import/export center for U.S. manufactured goods entering Mexico and Mexican agricultural goods entering the U.S. As of 1984, it is estimated that approximately 4,500 truck loads of produce may be brought into the U.S., via Nogales, each year (State of Arizona, 1985). In addition, the twin plant concept, in which an American manufacturer operates a plant in the U.S. and another in Mexico to realize the advantages of favorable wage differentials between Mexico and the U.S., has increased manufacturing activity significantly in recent years. Some 52 firms have operations in Nogales, mostly in apparel or electronics industries. Thus, the major thoroughfares (U.S. Hwy. 89, Interstate Hwy. 19, and Old Tucson Road) are heavily used by large trucks carrying goods to or from Mexico or the many warehouses in Nogales, Arizona.

7. ENVIRONMENTAL EFFECTS

7-1. The section on environmental effects of the recommended plan and alternatives analyzes only those alternatives that were carried to the final stage of analysis. Many alternatives were not carried to this final stage because it was determined earlier that they were not economically justified. Hence, only the recommended plan (Alternative #1), Alternative #2 (lower level of protection), and Alternative #4 (No Action) were evaluated for environmental effects. Table 2 compares the impacts of these three alternatives.

Biological Resources:

7-2. Impacts to biological resources from construction and operation of the Lateral Collector Channels (LCC's) are expected to be negligible since the area where they will be constructed is heavily urbanized and is expected to remain so into the future. Thus, the remainder of this impact analysis on biological resources addresses only the riparian habitat losses to Nogales Wash and Potrero Creek resulting from the Chula Vista Channel (CVC). No impacts are anticipated for the disposal site so long as the environmental commitment to avoid placing fill on existing vegetation or seasonal ponds and to avoid removal of existing vegetation is met. The recreation plan entails such low density use that no significantly adverse environmental impact is anticipated. Similarly, the flood warning system will not adversely impact biological resources to a significant degree.

Vegetation:

7-3. Recommended Plan: This alternative will result in losses of riparian

habitat along Nogales Wash from the southeast corner of Chula Vista to the confluence with Potrero Creek. In addition, a small area of riparian habitat will be lost at the west end of the CVC where it intersects with Potrero Creek just south of the Pete Kitchen mobile home park. Riparian habitat will also be lost along Potrero Creek between the west end of the CVC and the confluence with Nogales Wash in the future as this area is removed from the flood plain and rendered developable. Table 3 displays the acreage of riparian habitat expected to be lost as a result of initial construction of Alternatives #1 and #2. Plates 2 through 5 display extent and location of riparian habitat resulting from the current and future (with project and without project) conditions.

7-4. The information in Table 3 and Plates 2-5 was obtained from a vegetation map prepared via photointerpretation of aerial photographs (1 inch = 200 foot scale) combined with some field truthing. The project alignments (with all rights of way) were then overlayed over the vegetation map and the areas of riparian habitat (both existing and expected for the with and without project condition) determined by use of a digital planimeter.

7-5. The Habitat Evaluation Procedure (HEP) analysis conducted in conjunction with this project resulted in a mitigation plan that assures no net loss in average annual habitat units (AAHU's). In this analysis, habitat units consist of the product of habitat suitability indices (HSI's) which measures habitat value of a particular cover type and acreage measurements for each cover type. Each cover type had a different HSI value. HSI models calculate values between 0.0 and 1.0. A value of 1.0 indicates "prime" habitat. The goal of attaining no net loss of AAHU's assures that, over the economic life of the project, the net impact to habitat values (averaged over time) is negligible. Appendix C discusses in more detail the assumptions and methodology of the HEP analysis.

7-6. The HSI model utilized in the HEP was the Layers of Habitat Model developed by the Habitat Evaluation Procedures Group of the Fish and Wildlife Service in Fort Collins, Colorado (USFWS, 1984). This model relates structural complexity of the vegetation to habitat quality for wildlife. The basic assumption is that more structurally diverse habitats have more life requisite resources (e.g. food and reproduction) and in turn can support a more diverse assemblage of species. The model is especially appropriate for use on this project as it was developed in the same ecoregion. The number of layers of habitat is assumed to directly relate to structural complexity of the habitat.

7-7. The calculations of AAHU's enables the comparison of with-project and without-project conditions over the 100-year life of the project. Assuming that no mitigation plan was implemented (but assuming the aesthetic treatment plan is implemented), the net difference in AAHU's between the with-project condition for the recommended plan and without-project condition is -3.79.

Table 2 Comparison of Project Impacts.

Alt #	Impacts on Resources			
	Biology	Cultural	Aesthetics	Other
1	Loss of riparian habitat along Nogales Wash and Potrero Creek.	Possible loss of National eligible cult. resource sites	Loss of vegetation shielding along Nogales Wash. Also, adverse impact from concrete channels near heavily traveled border crossing.	
2	Same as Alt. #1, though of slightly less magnitude.	Same as Alt. #1, though with a slightly lower possibility.	Same as Alt. #1	
4	No impacts	No impacts	No impacts	

Table 3 Acres of Riparian Habitat Expected at Various Points in Time.

Recommended Plan (Alt. #1):

Cover Type	Existing	Immediately After Construction	100-Years After Construction
Cottonwood-Willow	8.48	4.09	2.00
Mixed Riparian	13.38	12.00	2.90
Mesquite	5.32	5.11	6.35
Newly Planted ROW	0.00	2.51	0.00*

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describes the general situation
of the country.

2. The second part of the document
describes the situation in the
different regions.

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through the metal grates. Water quality conditions will be improved overall as a result of the LCC's since overland flow from Mexico that is high in fecal coliforms (as happens when flooding breaks sewage pipes in Mexico) will be captured by the LCC's. Water quality conditions in the vicinity of Chula Vista will be unchanged. Poor quality water coming from Mexico will continue to flow down Nogales Wash even as it passes by Chula Vista. However, public exposure to this poor quality water will be reduced as public access to Nogales Wash will be restricted in the channelized portions by a 6-foot high chain link fence. Therefore, water quality impacts from the proposed plan are not expected to be significant. Water Quality impacts of Alternative #2 are identical to those of the proposed action. Present water quality conditions are expected to continue in the future, without significant change, under the No Action alternative.

7-25. Air Quality: Air quality impacts of the proposed plan and Alternative #2 are expected to be minor and short term during construction activities. No significant adverse impacts are anticipated. Under the No Action scenario, air quality in the project area is expected to continue to be good. The area is expected to remain an attainment area, but with continued particulates pollution emanating primarily from Mexico and the area's agricultural land use.

7-26. Noise: Noise impacts from the proposed plan and Alternative #2 are expected to be minor and short term during construction activities. No significant adverse noise impacts are anticipated. If no project is constructed, the existing noise conditions will continue into the future.

7-27. Transportation: Staged construction and detouring of lanes will be incorporated into the construction plan for the LCC's in order to maintain vehicular traffic across the international border. A portion of Army Blvd. will be blocked during emplacement of pipes and west end of the LCC. During construction will also be utilized for the east LCC to maintain pedestrian traffic across the international border. During construction of the east LCC and its pipe connections to the Nogales Wash Covered Channel, the southern end of International Street and the southern end of Robins Avenue will be the focus.

7-28. During construction of the two bridges over the CVC, traffic will be detoured around the project from the Old Tucson Road to U.S. Hwy. 89. Transportation impacts of the project are minor and short term. These impacts are not considered significant especially when compared against the without-project condition with its attendant frequent flooding at both the downtown and Chula Vista sites. Impacts of Alternative #2 are similar to those of the proposed action. Under the No Action alternative, transportation to and from Nogales, Arizona, will frequently be restricted due to flooding of the downtown area and/or Hwy 89 and Old Tucson Rd. near the Chula Vista community. These events could be expected to occur at any time of year as flooding occurs during both the winter and summer seasons.

Environmental Commitments:

7-29. Analysis of the environmental consequences of the recommended plan has resulted in the establishment of five environmental commitments (see also, table 4, below). Implementation of these environmental commitments will assure that the overall project has no significant environmental impacts.

1. Acquisition, habitat improvement, and fencing of all portions of Potrero Creek between the west end of the Chula Vista Channel (CVC) and the confluence with Nogales Wash (with the exception of only those portions of Potrero Creek which are bounded on both sides by residences). This area can be broken up into three different sub-areas. The first sub-area is a currently vegetated section of Potrero Creek located just downstream of the west end of the CVC. It is approximately 0.6 acres in size (assuming 60 ft width centered on the channel). The second sub-area is composed of that section of Potrero Creek located just downstream of the first sub-area to the point in the Pete Kitchen mobile home park where it is bounded on both sides by residences. The area to be acquired begins at 60 feet in width (centered on the creek) then narrows to 30 feet (located on the east side of the channel proper) as it enters Pete Kitchen where houses abut the creek on its west side. This sub-area is approximately 1.5 acres in size. The third sub-area entails that portion of Potrero Creek located downstream of Pete Kitchen and upstream of the confluence with Nogales Wash. This sub-area starts at 60 feet in width, but in the lower half widens to 75 or 80 feet in width to take advantage of existing riparian woodland areas. The total extent of this sub-area is 3.4 acres.

2. Purchase and fencing of the 2.7 acre densely vegetated depression located just north of the Chula Vista development and just west of Nogales Wash. This site has high value as wildlife habitat due to the dense cover of riparian vegetation. Fencing will exclude further grazing by nearby livestock.

3. Disposal of the approximately 127,000 cubic feet of excess fill material will take place in such a way as to avoid the covering of existing riparian vegetation or seasonal ponds and to avoid the removal of any riparian trees. The fill will be placed on areas currently lacking any significant vegetation. Should plans for disposal of excess fill material change significantly prior to construction, supplemental NEPA documentation will be prepared.

4. Aesthetic treatment of most of the right of way (ROW) along the CVC and along the Lateral Collector Channels (LCC). This treatment calls for the establishment of 2.5 acres of riparian woodland within the ROW. Species used in the ROW will include Cottonwood (Populus fremontia), Willow (Salix sp.), and Mesquite (Prosopis sp.). These species will be established by use of cuttings and pole planting as well as by seeding. The aesthetically treated ROW will also be irrigated for the life of the project through a permanent irrigation system to be installed in the ROW. The mitigation plan developed to address impacts to riparian habitat values (commitments #1 and #2, above) assumes that commitment #3 is in place (i.e. that the riparian habitat values accruing from commitment #3 is taken into account) The aesthetic treatment of the lateral collector channels (LCC) at the

international border involves painting of the grating covering the western LCC and installation of a color-coded fence along side the eastern LCC.

5. Prior to construction, the Corps will conduct subsurface testing for cultural resource sites along the CVC and LCC as specified in the Programmatic Agreement between the Corps, local sponsor, and State Historic Preservation Officer (Appendix D). This PA also specifies data recovery techniques to be employed (prior to construction) should any National Register eligible site be found.

8. COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

8-1. Relationship of Plans to Environmental Protection Statutes and Other Environmental

Requirements:

a. Clean Air Act: Potential impacts of the proposed action and alternatives have been assessed as appropriate. This EA has been submitted to the EPA Regional Administrator for review. No comments were received on the Draft EA.

Table 4 Environmental Commitments.

<u>Resource</u>	<u>Commitment</u>	<u>Action Required</u>	<u>Occur</u>	<u>Complete</u>
Riparian Habitat	Preservation of the small depression area.	Purchase and securing of the 2.7 acre densely vegetated depression area west of Nogales Wash and north of Chula Vista. The County of Santa Cruz will be responsible for acquiring this area in fee while the Corps will be responsible for erecting a fence around the site to exclude grazing animals. The County will also have Operation and Maintenance responsibilities for ensuring the integrity of the fence.	Prior to and during construction	Prior to completion of construction

Riparian Habitat	Preser- vation and habitat improvement along Potrero Creek.	Those portions of Potrero Creek between the western end of the Chula Vista Channel and the confluence with Nogales Wash (excluding that section where both sides of the creek are bounded by residences) will be purchased by the County and fenced by the Corps. The width is generally 60 feet centered on the actual water course. The Corps will also implement habitat improvement measures such as pole and cuttings plantings and seeding along the unvegetated areas for purposes of mitigation. The Corps will also be responsible for replacement of the low- flow pipe. The County will be responsible for O & M activities to ensure the future integrity of the fence and low-flow pipe. The total area included in this commitment is 5.5 acres.	Prior to and during cons- truc- tion	Prior to comp- letion of cons- truction
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Aesthetic values and riparian habitat.	Planting of riparian tree species and a permanent irrigation system in the CVC ROW. Also entails painting of the gate on the west LCC and erection of a color-coded fence on the east LCC.	The Corps will be responsible for aesthetically treating and fencing the project ROW to minimize adverse aesthetic impacts. By using riparian tree species, this treatment will also afford much riparian habitat value to riparian wildlife species. At least 2.5 acres of the ROW will be used for this commitment. Treatment of the LCC's will be the responsibility of the Corps. The County is responsible for maintenance of the irrigation system and the fences.	During and after construction of the CVC	After construction of the CVC
Cultural resources	Subsurface testing of the CVC and LCC sites for sites eligible for the National Register. With data recovery should any sites prove eligible.	As stipulated in detail in the attached Programmatic Agreement between the Corps, and SHPO, the Corps is committed to conducting preconstruction subsurface testing of the project alignments. Also, as stipulated in the PA, the Corps is committed to a data recovery program should any sites found prove eligible for listing on the National Register of Historic Places.	Prior to initiation of construction	Prior to initiation of construction
Riparian Habitat and Seasonal Ponds.	Avoidance of existing riparian habitat and seasonal ponds at the excess fill disposal site.	Disposal activities for the excess fill will be restricted such that no high quality riparian habitat or seasonal ponds will be removed or covered by the fill material.	During construction	After Construction

b. Clean Water Act: The proposed project entails discharge of dredged or fill material into waters of the United States. A water quality evaluation has been prepared pursuant to Section 404(o)(1) of the Act and is appended (appendix E) to this document. In addition, State certification under Section 404R was requested from the Arizona Dept. of Environmental Quality. Although the State has not yet formally responded, informal telephone coordination with Mr. James Huston (Office of Water Quality) indicate that the project is in compliance as per Section 404R and that a letter will be forthcoming shortly.

c. Endangered Species Act: A list of Federally threatened and endangered species was requested of USFWS by letter on May 29, 1984 (appendix A). A letter (dated June 7, 1984) listing the species was received by the Corps (Appendix A). The list was further verified informally on March 13, 1987 by telephone conference (Appendix A). The species listed were as follows:

Candidate species: None
Proposed species: None
Threatened Species: None
Endangered species: Bald eagle (Haliaeetus leucocephalus)
Peregrine falcon (Falco peregrinus)

No proposed or endangered species would be affected by the proposed project. USFWS has concurred with this finding formally in the Fish and Wildlife Coordination Act Report, dated February 11, 1988 (Appendix B).

d. Farmland Protection Policy Act: A coordination letter and form AD 1006 were sent to Soil Conservation Service (SCS) on March 18, 1987. SCS returned the form with a letter dated March 25, 1987. The Corps then sent additional project information and resubmitted form AD 1006 on June 9, 1987. SCS returned the form with a letter dated July 7, 1987. Copies of these letters and records of intervening telephone conversations are included in appendix A. Form AD 1006 is used to rate alternative project sites or plans by assigning points to each. Higher point ratings indicate a more significant impact on prime and unique farmlands. In general, a point rating of 160 or more indicates that alternative plans or sites should be considered. The recommended plan is less than 160 points and consequently has no significant adverse impact on farmland resources.

e. Federal Water Project Recreation Act: Compliance with this statute is assured by incorporation of a recreation plan as part of the recommended plan.

f. Fish and Wildlife Coordination Act: The Corps has coordinated informally with The U.S. Fish and Wildlife Service (USFWS) and the Arizona Department of Game and Fish (ADGF) during the preparation of this document. Each of these agencies, along with the Corps, took part in scoping meetings, HEP team meetings, and field data collection. A record of formal coordination with USFWS and ADGF is displayed in Appendix A. USFWS sent the Corps a Planning Aid letter on June 10, 1984 and a Draft Coordination Act Report (DCAR) on February 10, 1987. The Final Coordination Act Report is presented in Appendix B.

g. National Environmental Policy Act: This EA has been prepared in accordance with NEPA requirements. Reasonable alternatives to the proposed action have been considered during the planning process. Potential environmental effects have been included in the evaluation of the project. Procedural review requirements have been met.

h. National Historic Preservation Act: The Corps has conducted preliminary studies to identify National Register properties that would be affected by the proposed project. Full compliance with the Act requires testing for buried sites, and possible testing to evaluate significance of sites identified during initial testing. Continued consultation with the Arizona State Historic Preservation Officer (SHPO) and the Advisory Council for Historic Preservation (ACHP) may also be required to identify appropriate treatment of significant cultural resources that will be affected. A Programmatic Agreement (PA) with stipulations for these additional studies, consultation, and treatment of historic properties has been negotiated with the SHPO and the ACHP. This PA was signed by the Corps and SHPO. The PA is included in appendix D.

i. Rivers and Harbors Act: Section 122 of this act requires that significant economic, social, and environmental effects of proposed water resources developments be considered in order that final project decisions are made in the overall public interest. Compliance with NEPA and the lack of any significant environmental effects establishes compliance with the River and Harbors Act.

j. Executive Order 11988, Floodplain Management: Project planning and formulation of alternatives considered the objectives of this Order. Although this flood control project must be constructed within the floodplain, floodplain values would be protected by minimizing the extent of channelization (restricting the channel to the south and east sides of the Chula Vista Community) and by incorporation of the mitigation and aesthetic treatment plans to minimize and avoid adverse impacts to environmental values.

k. Executive Order 11990, Protection of Wetlands: There is no practicable alternative to locating the proposed action in wetlands. The proposed action includes the following measures to minimize harm to the wetlands and preserve and enhance the natural and beneficial values:

1. Minimizing the extent of channelization.
2. Incorporation of the mitigation and aesthetic treatment plans.

Impacts of the proposed action and its alternatives are discussed under the above heading "Environmental Effects". Concerns relating to wetlands are discussed in the Section 404(b)(1) water quality evaluation for the project included in appendix E.

1. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions: Although the portions of the proposed project are located directly adjacent to the international border with Mexico, no environmental effects are expected to occur in Mexico. The proposed project has been

coordinated with the U.S. Section of the International Boundary and Water Commission (IBWC). The EA was sent to the U.S. Section of the IBWC for review. Their comments and Corps responses are presented in Appendix F.

m. State and Local Policies and Laws: This EA was reviewed by appropriate State and local agencies in order to assure that applicable policies and laws have been adequately considered. Their comments and Corps responses are presented in Appendix F.

n. Land Use Plans: The proposed project does not conflict with local land use plans as it simply reduced flooding to areas already developed or zoned for development.

9-1. **COORDINATION:** The DEA was sent out for a 30-day public review. The following agencies, groups and individuals received a copy of the DEA for review and comment:

U.S. Fish and Wildlife Service
Environmental Protection Agency
Bureau of Land Management
U.S. Geological Survey, Water Resources Div.
Advisory Council on Historic Preservation
Soil Conservation Service
U.S. Section, International Boundary and Water Commission
Elected Federal, State, and Local Officials
Arizona State Historic Preservation Officer
Arizona Office of Economic Planning and Development
Arizona State Clearinghouse
Arizona Water Commission
Arizona State Lands Commission
Arizona Dept. of Transportation
Arizona Dept. of Health Services
Arizona Dept. of Game and Fish
Arizona Dept. of Water Resources
Interested Individuals and Organizations

10-1. **LIST OF PREPARERS:** The following people were primarily responsible for preparing this assessment.

<u>Name</u>	<u>Experience</u>	<u>Expertise</u>	<u>Role in EA Prep</u>
David Castanon	3 years	Environmental planning and biological resource evaluation.	Writing of Environmental Assessment including sections on biology
Laura Tschudi	12 years	Environmental planning	Review of EA

Terry Breyman	10 years	Biological resources	Review of biological resource sections of EA
Michael Noah	6 years	Biological resources	Review of biological resource sections of EA
John Kennedy	12 years	Environmental planning	Review of EA
Nedenia Kennedy, Ph.D.	2 years with COE. 5 years teaching	Cultural resources management	Cultural resources investigations and writing of cultural resource sections of EA
Pat Martz, Ph.D.	14 years	Cultural resources management	Review of cultural resource section of EA

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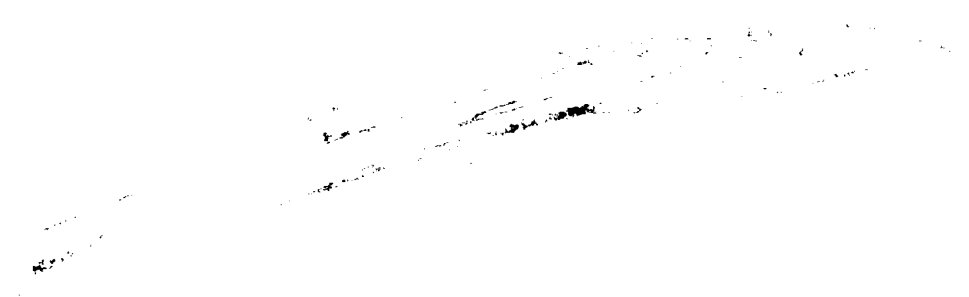
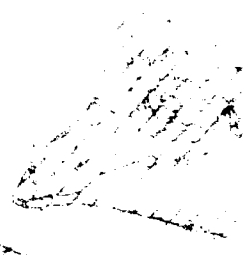
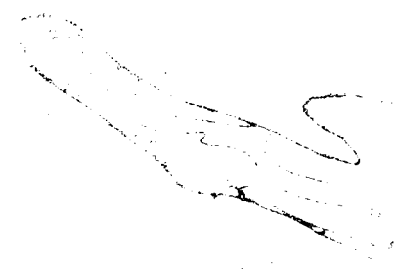
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6 HIGHWAY 99



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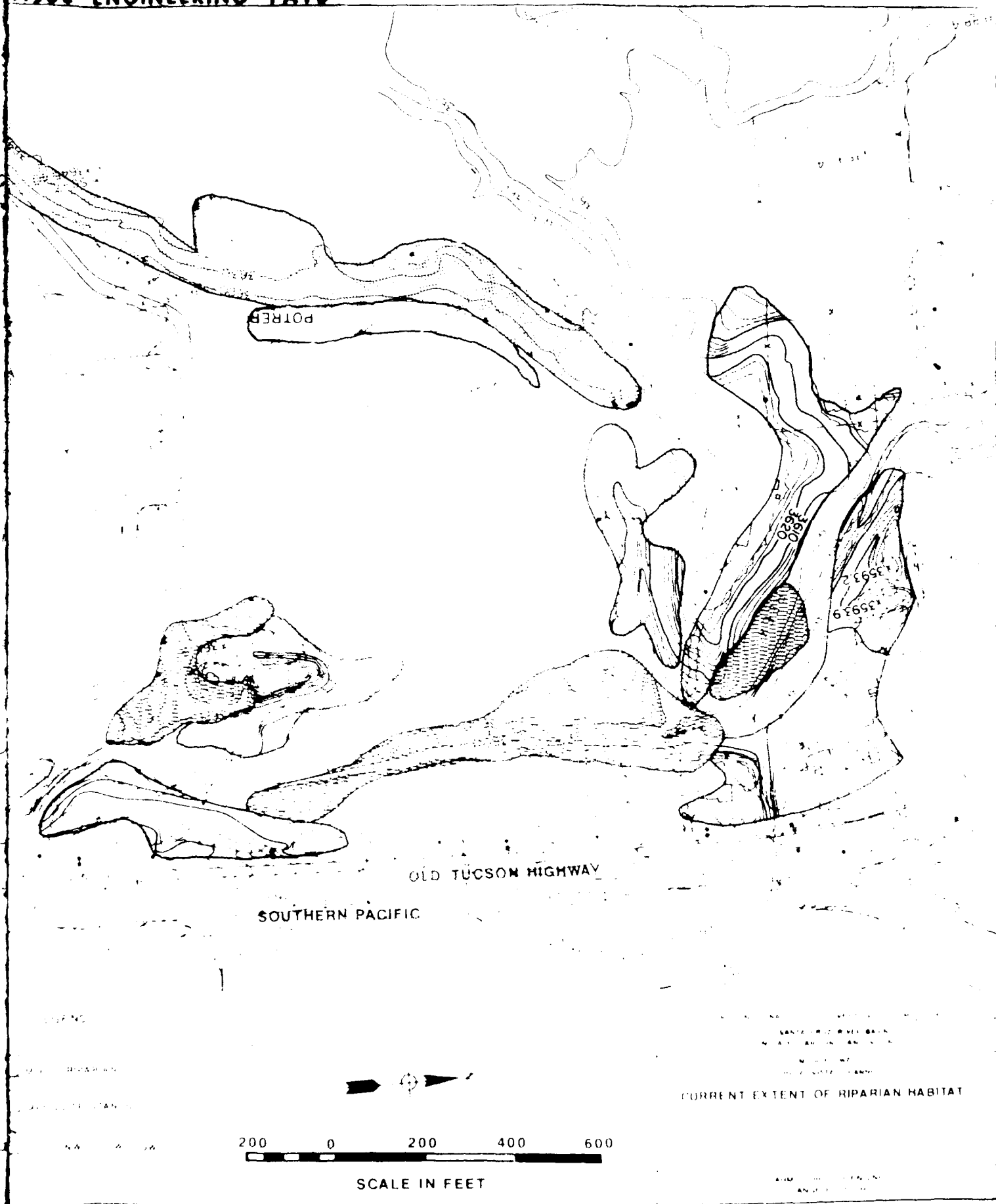


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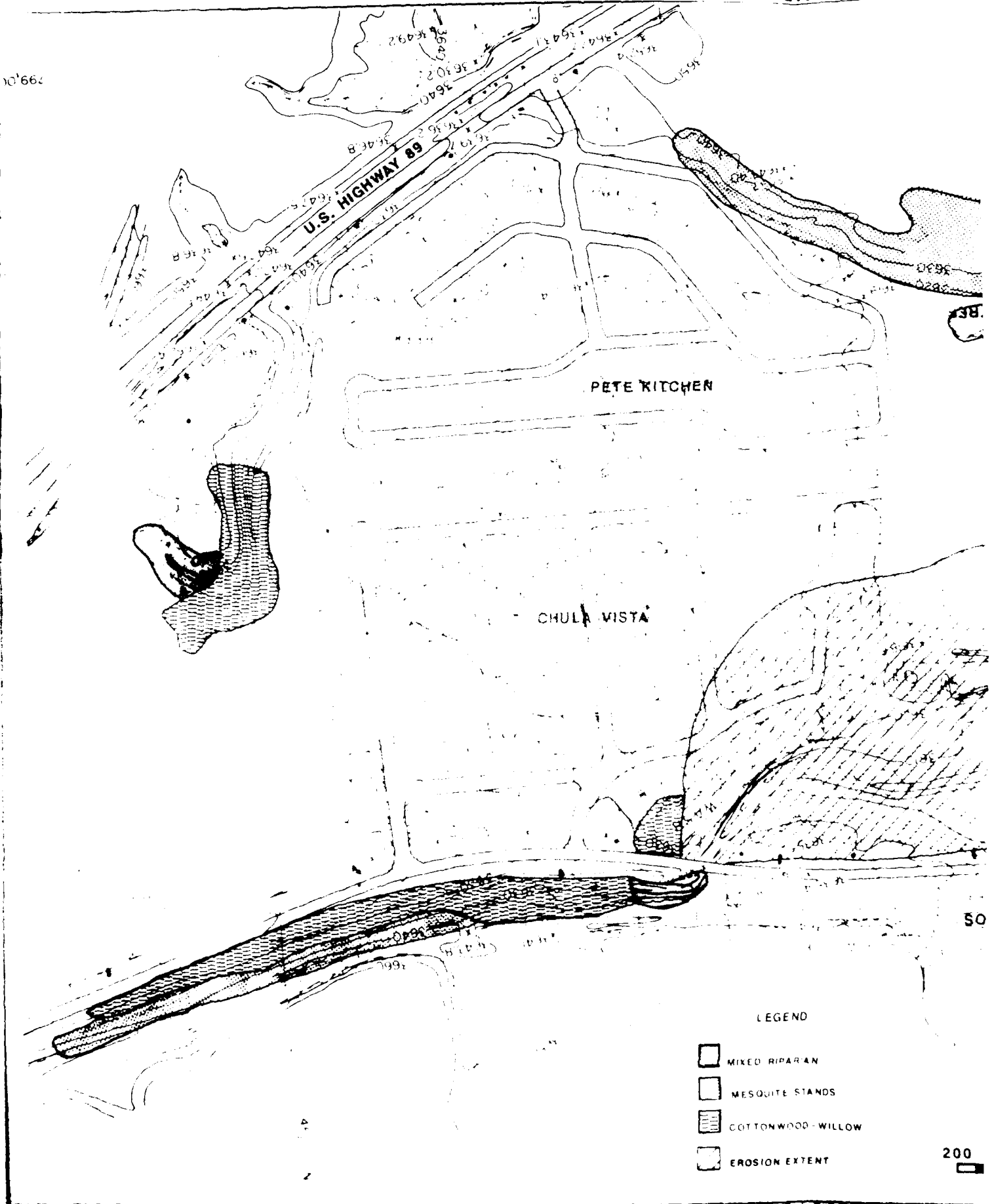
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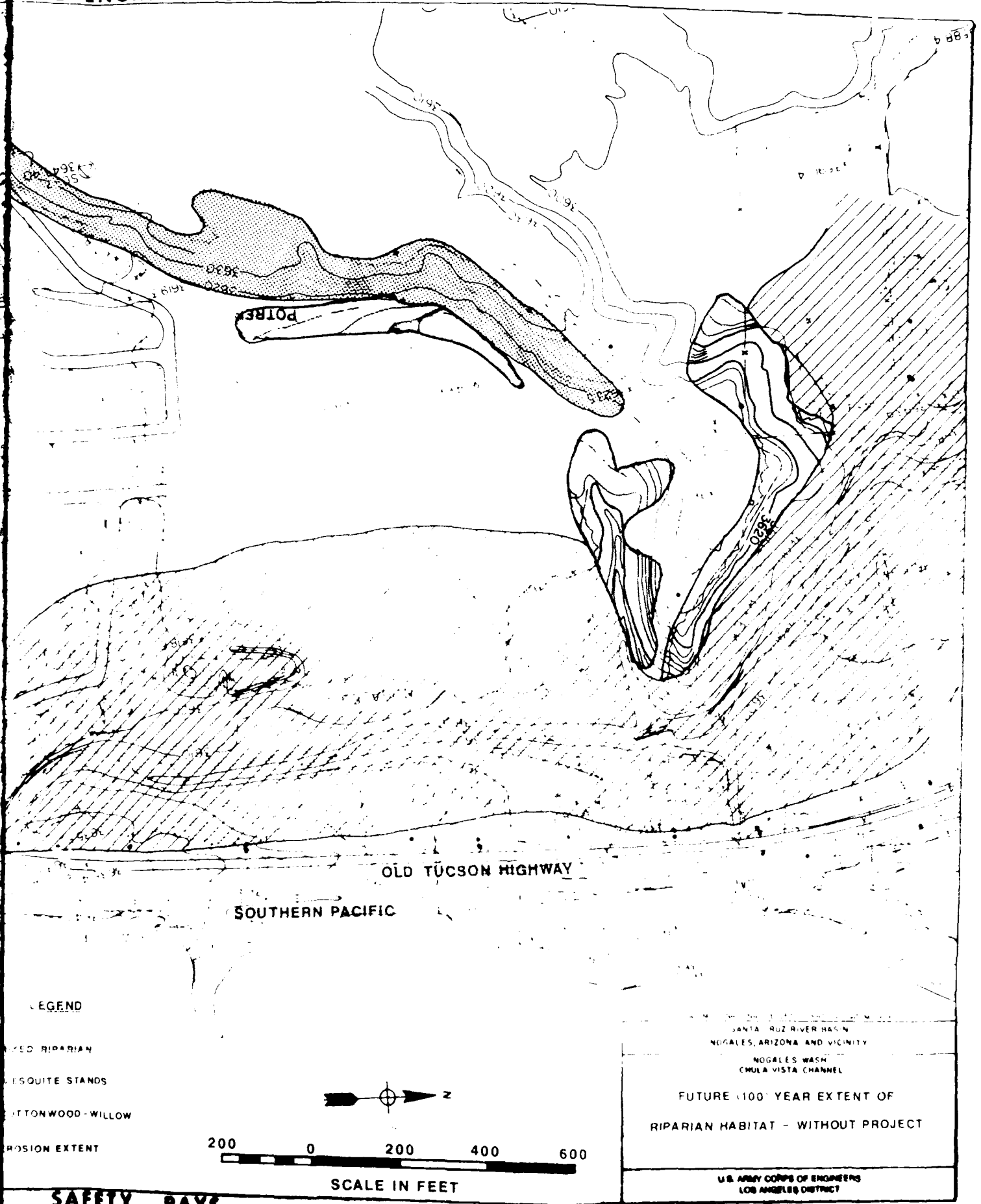


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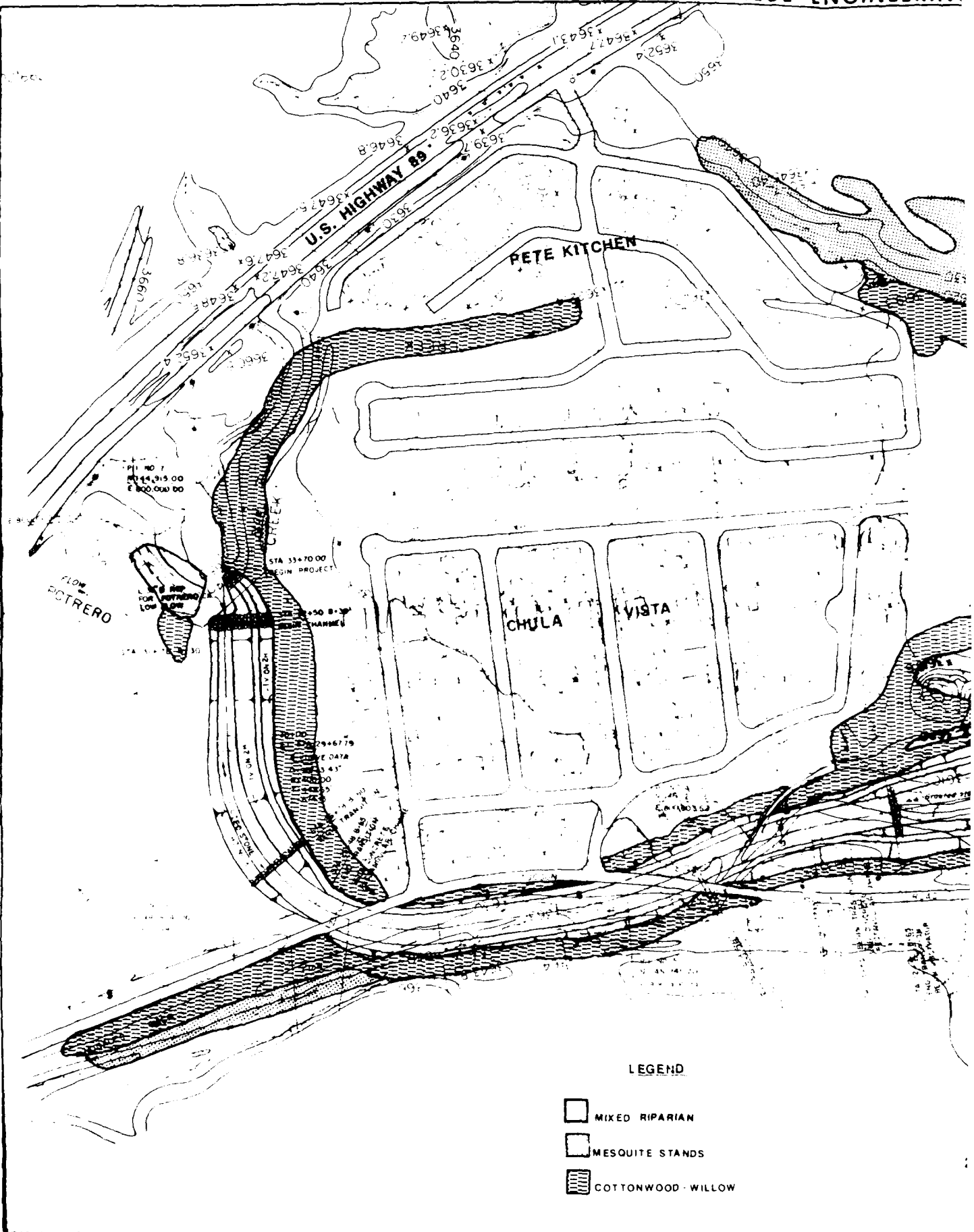


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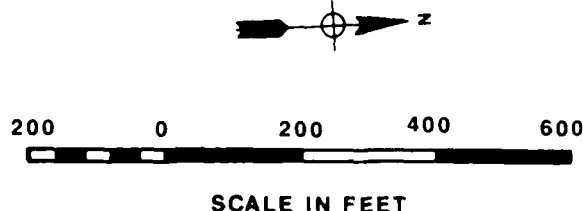


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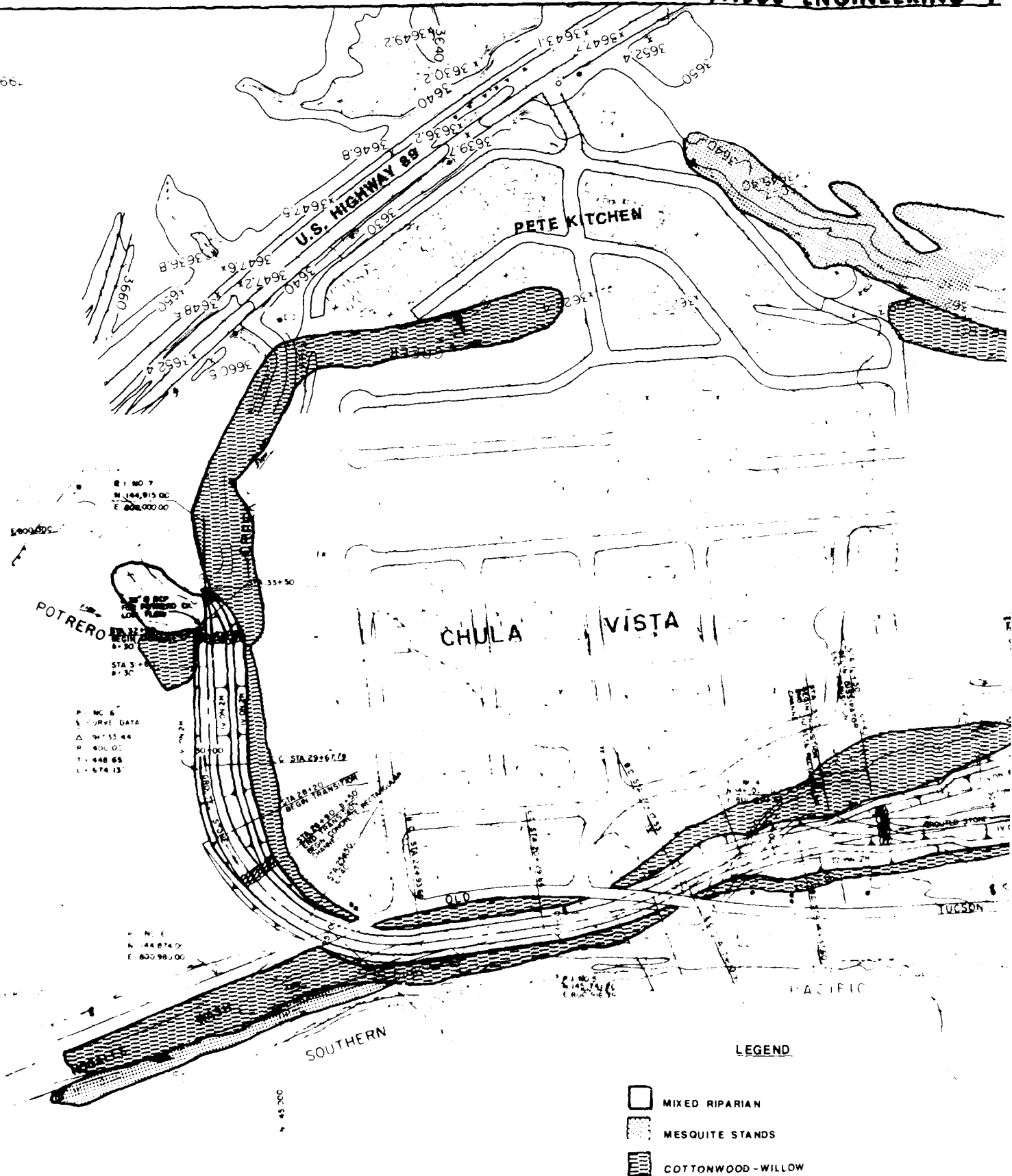
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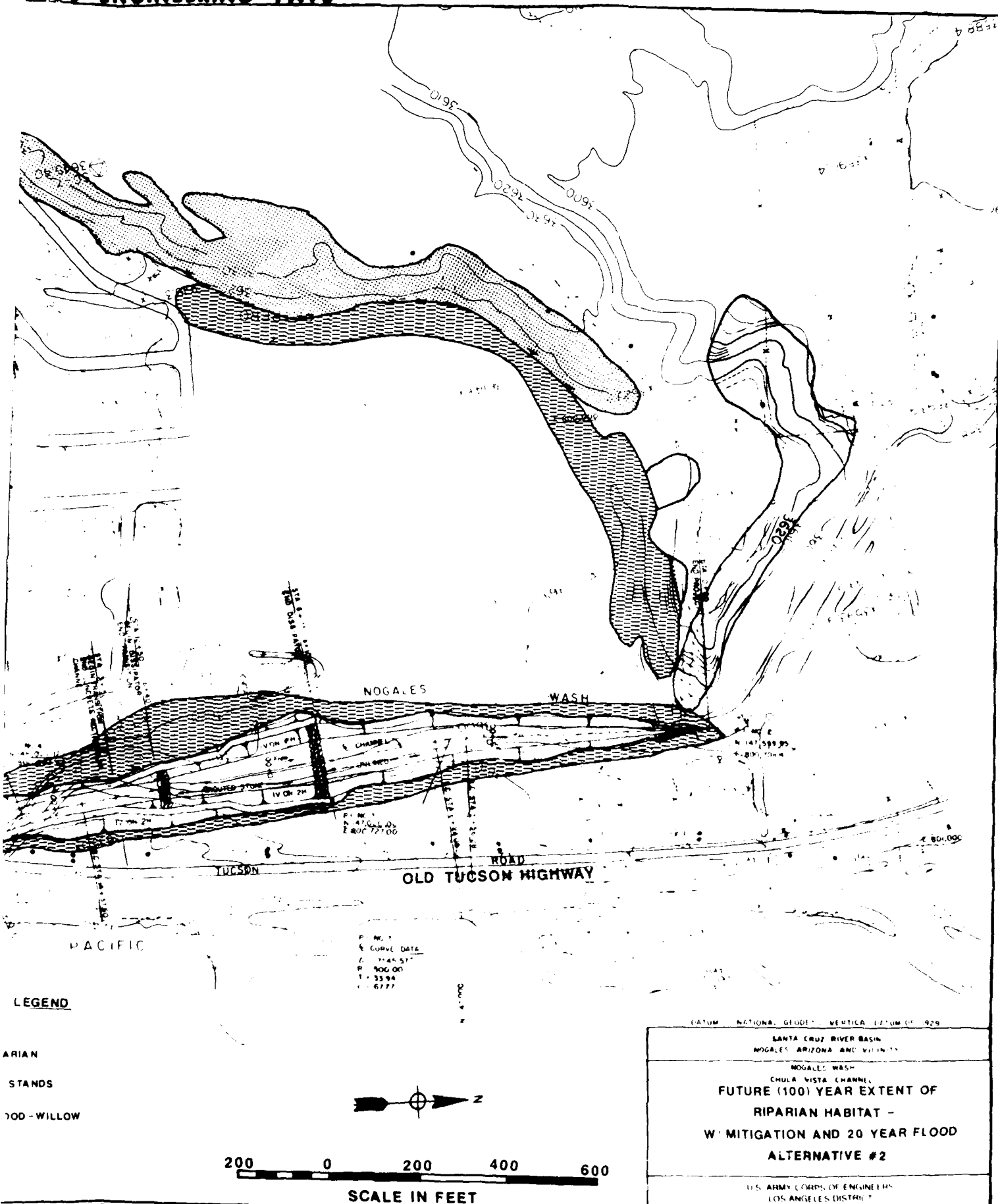
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- ☐ MESQUITE STANDS
- ☐ COTTONWOOD - WILLOW



AT M. S. NATIONAL REDETERMINED DATUM 1983
SANTA CRUZ RIVER BASIN
NOGALES, ARIZONA AND VICINITY
NOGALES WASH
CHULA VISTA CHANNEL
FUTURE (100) YEAR EXTENT OF
RIPARIAN HABITAT -
W/ MITIGATION AND 100 YEAR FLOOD
ALTERNATIVE #1
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

ENVIRONMENTAL
ENGINEERING
THRU ENGINEERING





APPENDIX A

RECORDS OF CORRESPONDENCE



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Ecological Services
334 W. Fairmount Avenue
Phoenix, Arizona 85017

2-21-94-Y-62

June 7, 1984

Mr. Carl F. Enson, Chief, Planning Division
Corps of Engineers, Los Angeles District
P. O. Box 2711
Los Angeles, California 90053

Dear Mr. Edison:

This is in response to your letter dated May 29, 1934, concerning the Naval Warship Control Project. As provided by Section 1 of the Endangered Species Act, the Fish and Wildlife Service initiates, upon request, a list of federally listed and proposed species that may be affected by Federal actions. This office has used the information in your request to narrow the list of listed, proposed and candidate species which occur in Santa Cruz County, Arizona, to those that potentially may be affected by your proposed action (see enclosure).

If the Federal action is considered a major action significantly affecting the quality of the human environment, the Federal agency authorizing, funding, or carrying out the Federal action will conduct a biological assessment to determine whether or not the Federal action will affect listed or proposed species. Preparation of the assessment may begin upon receipt of the Fish and Wildlife Service's species list.

The biological assessment shall be completed within 180 days after receipt of the effective list, unless it is mutually agreed to extend this period. If the assessment is not initiated within 90 days after receipt of the species list, the requester may request its accuracy be verified before conducting the assessment.

The biological assessment should include as a minimum:

- on the inspection of the area affected by the proposed activity or program, including a detailed survey of the area to determine if species are present and whether suitable habitat exists for either: expanding the existing population or potential reintroductions of populations;

TELEPHONE OR VERBAL CONVERSATION RECORD		DATE
Use of this form use see 540-15 Use appropriate Agency & the Adjutant General's Office		21 May 64
SUBJECT OF CONVERSATION		
PERSON CALLING	INCOMING CALL	
PERSON CALLED	ADDRESS	PHONE NUMBER AND EXTENSION
	OFFICE	PHONE NUMBER AND EXTENSION
PERSON CALLING	OUTGOING CALL	
PERSON CALLED	OFFICE	PHONE NUMBER AND EXTENSION
PERSON CALLED	SPED. RE. ADDRESS	459-0314
PERSON CALLED	PERSON CALLED	PHONE NUMBER AND EXTENSION
PERSON CALLED	PERSON CALLED	8-203-100-111
SUMMARY OF CONVERSATION		
<p>ACHS does have water quality data for Nogales Wash. There is a lot of bacteriological (fecal coliform) data taken near the border (long period of record). Tucson lab took samples and performed analysis. All data has been given to the International Boundary Commission.</p> <p>Overloaded sewer system on the Mexican side. Inflow and infiltration problems during rain. Man-hole covers pop and raw sewage enters Nogales Wash. There is a chlorination facility at the border on the U.S. side. Flows in the wash do infiltrate into the alluvium that groundwater is then used by locals for various needs.</p> <p>Contact Mary Day for the Nogales Wash file (AWQ 1000 file).</p>		

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THE UNIVERSITY OF CHICAGO

- 2) interviews with recognized experts on the species at issue, including personnel of the Fish and Wildlife Service, of State conservation departments, of universities, and others who may have data not yet found in scientific literature;
- 3) review literature and other scientific data to determine the species distribution, habitat needs, and other biological requirements;
- 4) review and analysis of the effects of the proposed action on individuals and populations, including consideration of both direct and indirect effects of the proposal on the species and its habitat;
- 5) analysis of alternative actions that may promote conservation of the species;
- 6) other relevant information; and
- 7) written report documenting the assessment results.

If the Federal permitting action is not a major action significantly affecting the quality of the human environment, there is no need to prepare a biological assessment. However, it remains incumbent upon the Federal agency to assess whether its action may affect endangered and threatened species.

If the Federal agency determines that its proposed action may affect listed species, the Federal agency shall initiate the formal Section 7 consultation process by writing to this office. If no effect is evident, there is no need for further consultation. However, we would appreciate the opportunity to review your biological assessment.

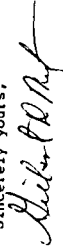
In addition, the Act (Sec. 7(a)(3)) requires Federal agencies to confer with the Service on any agency action likely to either jeopardize the continued existence of any species proposed for listing as endangered or threatened or adversely modify proposed critical habitat. The purpose of this requirement is to identify and to resolve at the early planning state of an action all potential conflicts between the action and the respective species and critical habitat. The informal Section 7 consultation process can accomplish this requirement.

Candidate species include those listed in a "Notice of Review" in the "Federal Register" but later withdrawn, those species which are in the process of being listed, or those which are the subject of contrasted status surveys. These

Candidate species have no legal protection under the Endangered Species Act but are species for which the Service has substantial information to support their listing as endangered or threatened. The development and publication of proposed rules for such species is anticipated. They are included in this document for planning purposes only.

If you have need of further assistance, please call this office at PTS 261-2493.

Sincerely yours,


Gilbert D. Metz
Field Supervisor

Enclosure

cc: Director, Arizona Game and Fish Department, Phoenix, Arizona
Regional Director, (SD), (AHR), Fish and Wildlife Service, Region II,
Albuquerque, New Mexico



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Ecological Services
2934 W. Fairmount Avenue
Phoenix, Arizona 85017
July 10, 1984



Col. Dennis P. Butler
Commander
Los Angeles District
U.S. Corps of Engineers
P. O. Box 2711
Los Angeles, California 90053

Dear Sir:

This report constitutes our Planning Aid Letter as requested in our 1984 Scope of Work for the Nogales Wash Flood Control Project in Santa Cruz County, Arizona. This report contains a general description of the existing environment and its regional significance, a brief discussion of project impacts and recommendations for further biological studies.

Existing Environment

Physical Features

The project area is located in southern Santa Cruz County, Arizona. Nogales Wash rises in the mountains of Sonora, Mexico and flows north through the city of Nogales, Sonora across the international border into the city of Nogales, Arizona. The wash crosses the border in a covered, concrete channel which was constructed in the 1930's by the International Boundary and Water Commission. Approximately .75 mile north of the border, the channel becomes an open concrete channel running adjacent to Grand Avenue (AZ 89) and a Southern Pacific Railroad line. This area is within the urban center of Nogales, commercial and residential areas flank both sides of the channel. Drainage from Ephraim Canyon Wash and city streets enter the channel along this reach.

The concrete channel ends abruptly after approximately 1.25 miles and the wash is then contained in a steep sided, well defined natural channel. The highway and railway line still flank the wash but the urbanization is not as dense. Industrial areas flank the east side with commercial areas scattered along the west side of Grand Avenue. Some gablons are in place along this reach.

Approximately 2 miles north, the rail line crosses from the east to west bank of the wash. Above the railroad bridge there is evidence of extensive channel work. Concrete slabs line both sides of the wash north for 1 mile to the Nogales city limit. In many places the concrete slabs are eroded out completely and concrete rubble litters the wash bottom. Other slabs are still in place but the wash bed is lower than the bottom edge of the slab. There

Washed Wash Flood Control Project
Santa Cruz County, Arizona

Listed Species

Migratory birds may utilize project area for feeding or resting.

Migration or resident birds may use project area for feeding.

Promised Species

None

Critical Habitat

None

Candidate (Category 1) Species

None

It does not seem to be concrete lining the wash bottom. This work is quite old as evidenced by the presence of 4-5 inch diameter trees growing on debris overlying the concrete and similarly large trees growing in the wash bottom. The concrete is a different color than that used in the 1930's channel which indicates that this work was not done at that time. The channel in this area is in very poor condition and severe bank erosion exists.

The reach above the city limits is flanked by the Old Tucson Road and the railroad line. Some light residential and industrial areas occur in this area. The wash crosses to the west of Old Tucson Road, a half mile above the city limits. The narrow channel widens considerably into a broad flood plain flanked in some areas by steep eroded banks. Potrero Creek empties into the wash in this reach. The upper end of this reach is agricultural/pasture land.

There are a few homesteads along the wash, above the northern crossing at Old Tucson Road. The channel is narrower than the preceding section but wider than the Grant Avenue section and is well defined and clear. There is some erosion visible but the cut banks are low.

The final section extends from the Ruby Road Bridge to the Waste Water Treatment Plant. Industrial parks are being developed on the west bank of the wash adjacent to Interstate 19. The rail line continues to parallel the wash. The channel here is well defined and clear with some areas of considerable bank erosion and other areas with none at all.

Biotic Features

A field survey of the project area was made in April 1984 by Fish and Wildlife Service Personnel. The survey was not designed to be either qualitative or quantitative, but to provide some basic information on the biotic resources of the wash. Photographs of representative areas are located in Appendix 1.

Nogales Wash supports areas of extensive riparian deciduous woodland with cottonwoods (*Populus fremontii*), willow (*Salix* sp.), mesquite (*Prosopis* sp.) and Mexican elder (*Sambucus mexicana*) the dominant tree species. The trees range in size from saplings to extremely large, mature specimens. There are areas of cottonwood alluvial forest south of the northern Old Tucson Road Bridge and a willow forest south of the waste water treatment plant.

The southern concrete channel has limited wildlife values. Some small mammals are present adjacent to the channel. There are approximately 10 large trees growing in the area of the old bridge on Grant Avenue that are used by about 1000 birds. The *Myiarchus cinerascens* is a major species.

The northern concrete channel has limited wildlife values. Some small mammals are present adjacent to the channel. There are approximately 10 large trees growing in the area of the old bridge on Grant Avenue that are used by about 1000 birds. The *Myiarchus cinerascens* is a major species.

Large cottonwoods and willows with stringers of young trees are characteristic of the section between the Old Tucson Road Bridges. As mentioned earlier, this area resembles the cottonwood gallery forest with its tall, old cottonwoods and stringers of young trees on banks and bars.

Large trees with moderate understory or stringers of smaller trees are characteristic of the remainder of the project area to the waste water treatment plant. The small mesquite bosque is in this area.

A total of 17 bird species were identified on the field survey (Table 1). This number is by no means an accurate representation of the number of bird species that utilize this habitat type. Arizona Game and Fish Department (AGFD) (1983) in their contracted study for the Bureau of Reclamation (BR) on the project area for the Tucson Aqueduct Phase B (Central Arizona Project) reported a total of 87 bird species utilizing riparian deciduous woodland.

The 1978 Audubon Christmas Bird Count recorded 155 species from all habitats in the Nogales area (Helfrich 1979).

Several species of mammals, reptiles and amphibians would be expected to utilize this riparian area. The AGFD study for the Tucson Aqueduct found 9 species of reptiles and amphibians and 5 species of small mammals in the riparian deciduous woodland.

According to City of Nogales personnel, the wash has had a more or less continuous flow from Mexico for the last 2 years. Apparently some of the flow is sewage discharge, however the flow is clear and non-odorous. Cladophora was observed floating in the current. No attached algae was seen. Small schools of fish, probably long fin dace (*Alosa chrysodactylus*), were observed in the stream at several locations.

Our data indicates that no federally listed endangered or threatened species are resident in the project area. We expect that both peregrine falcons (*Falco peregrinus*) and bald eagles (*Haliaeetus leucocephalus*) would utilize this area during winter migrations.

The Nogales Branch of AGFD maintains a computerized system of species occurrence records on riparian stream plant and animal species. Species in the system include federally listed, proposed and candidate species under the Endangered Species Act and species on Arizona's Threatened Native List. Table 2 lists those species with records from the Nogales Wash area or that are likely to occur in the area. Category 1 candidates are species published in a Notice of Review in the Federal Register for which the Fish and Wildlife Service does not have sufficient information at this time to support their being listed as threatened or endangered. Category 2 species are those that the State of Arizona has listed as threatened or endangered. Category 3 species are those species with Federal listings that are not currently listed as threatened or endangered. Category 4 species are those species with Federal listings that are not currently listed as threatened or endangered. Category 5 species are those species with Federal listings that are not currently listed as threatened or endangered.

Flooding

The flood events of 1977, 1980 and 1983 have resulted in considerable modification to stream banks, flood control structures and vegetation. Extensive areas of cut banks, debris piles and occasional fallen trees are evident throughout the nonchannelized sections of the wash. Repair work on washed out gabions and other flood protection structures is ongoing. Heavy equipment has been used in the wash itself to move debris and sediment. Future flood events could further damage and erode the wash.

Recommended Status

Biological

Very little biological work has been done on Nogales Wash. Prior to any detailed assessment of impacts from a proposed Corps project, certain data will be required. At the very least, an inventory of animal species and a detailed map of plant distribution would be required. A Habitat Evaluation Procedure (HEP) study would be appropriate if your plans include substantial modifications to the existing wash.

Riparian systems are extremely important to wildlife in the desert southwest, providing areas of food, cover and water for both resident and migratory species. This habitat type has been severely reduced in both quality and quantity by water depletions, active cutting and land use changes to the detriment of wildlife species that depend upon it.

Our mitigation policy, FR Vol. 46, No. 15, January 23, 1981, directs us to designate specific resource categories for various habitat types in our areas of responsibility. The purpose of this policy is to allow Federal action agencies and private developers to anticipate Service recommendations and plan for mitigation measures early, thus avoiding delays and assuring equal consideration of fish and wildlife resources with other project features and purposes.

We have determined that the riparian woodlands in this project area qualify for status on Resource Category 2. This means that this habitat is of high value for evaluation species and is relatively scarce or becoming scarce or a national basis or in the ecoregion section. Our mitigation goal will be no net loss of in-kind habitat value.

General

A history of flood events and flood control work done would be useful in evaluating the present situation.

Project Alternatives

There is a wide range of possible flood control measures that could be used by the Corps to deal with the problems along this wash. Alternatives that would channelize extensive areas of the wash would be unacceptable in our opinion as they would destroy the valuable riparian habitat. Plans that emphasize bank stabilization, removal of man-made obstructions or upstream retention structures to control flow would likely be more acceptable to our agency.

Sincerely yours,

Gilbert D. Metz

Gilbert D. Metz
Field Supervisor

cc: Director, Arizona Game & Fish Department, Phoenix, Arizona
Regional Director (ARR), Fish & Wildlife Service, Region 2, Albuquerque,
New Mexico

Bibliography

Arizona Game and Fish Department. 1983. Final Report for the Biological Resource Inventory: Tucson Division - Phase B Central Arizona Project Aqueduct. Prepared under contract to U. S. Bureau of Reclamation (contract #32-V0151). 470 pp.

McIlhenny, L. H. (ed.). 1979. Seventy ninth Christmas Bird Count. American Birds.

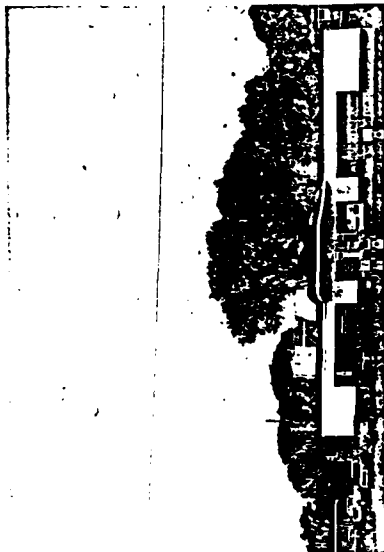
Table 1 Bird Species Identified on Nogales Wash April 2-4, 1984

Killdeer	Charadrius vociferus
American kestrel	Falco sparverius
Red-tailed hawk	Buteo jamaicensis
Turkey vulture	Cathartes aura
Mourning dove	Zenaidura macroura
Barn swallow	Hirundo rustica
Rough-winged swallow	Stelgidopteryx ruficollis
Ladderback woodpecker	Picoides scalaris
Common flicker	Colaptes auratus
Vermilion flycatcher	Pyrocephalus rubinus
Unident. flycatcher	Empidonax sp.?
House finch	Carpodacus mexicanus
Starling	Sturnus vulgaris
Lark sparrow	Chondestes grammacus
Red-winged blackbird	Agelaius phoeniceus
Eastern meadow lark	Sturnella magna
Raven	Corvus corax

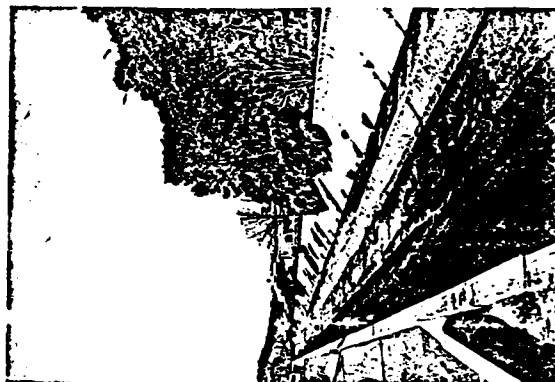
Table 2 Special Status Species Reported from the Nogales Wash Area

	Category 2 candidate (federal)
Heardless Cinch Weed (<u>Pectis imberbis</u>)	Group 3 (state)
Mexican Garber Snake (<u>Thamnophis eques</u>)	Group 3 (state)
Desert Hooknosed Snake (<u>Crotaphytus</u> <u>indivirgatus</u>)	Group 2 (state)
Grey Hawk (<u>Buteo nitidus</u>)	Group 3 (state)
Northern Beardless Tyrannulet (<u>Camptostoma</u> <u>imberbe ridgwayi</u>)	Group 4 (state)
Black-Bellied Whistling Duck (<u>Dendrocygna autumnalis fulgens</u>)	
Species likely to occur but not recorded on Nongame system	
Mountain Skink (<u>Eumeces callicephalus</u>)	Group 4 (state)
Plains Narrow-Mouthed Toad (<u>Gastrophryne</u> <u>olivacea</u>)	(No official status)
Yaqui Black-Headed Snake (<u>Tantilla yaquia</u>)	Category 2 candidate (federal)
Western Yellow-Billed Cuckoo (<u>Coccyzus</u> <u>americanus occidentalis</u>)	Group 3 (state)
Thick-Billed Kingbird (<u>Tyrannus crassirostris</u>)	Group 3 (state)
More-Throated Becard (<u>Pachyrhamphus agelaius</u> <u>richmondii</u>)	

1. Turkey vulture roost site near the confluence of Nogales Wash and Ephraim Canyon Wash



2. View of concrete channel. Note side channel for Ephraim Canyon Wash and mature cottonwood trees with turkey vultures





3. View from Babes and Animal Control Office. Note change in channel banks beyond tree growing in wash



4. View from the channel. Notice that the channel banks are no longer



5. View upstream from Mariposa Road bridge. Note stands of young trees



6. View upstream from unnamed bridge about 1/4 mile north of Baffert Road bridge. Note bank erosion



7. View upstream toward railroad bridge crossing (about 1 mile north of Baffert Road). Note re-establishment of concrete lining and washed out bank protection structures



8. View downstream from Highway Patrol Station. Note severe erosion and overgrowth on concrete bank lining



9. Behind Highway Patrol Station. Note severe erosion and destruction of concrete lining. Trees in center background are in wash bed



10. Behind Highway Patrol Station. Note destruction of lining and large tree growing on bank edge



11. View of Inlet structure, $\frac{1}{2}$ mile north of Highway Patrol Station. Note mesquite tree overgrowing structure



12. South of Potrero Creek-Mogajon Wash confluence. Note steep cut banks



13. View $\frac{1}{2}$ mile north of Potrero Creek confluence. Note cottonwood trees and eroded banks



14. View $\frac{1}{2}$ mile south of Old Tucson Road bridge. Remnant gallery forest



17. View near northern end of project area. Note bank erosion



15. View north from Ruby Road bridge. Note railroad line and construction related clearing flanking the wash



16. View north of Ruby Road, at railroad crossing. Construction activity in background with some work in wash bed. Note fallen trees

BRUCE BABBITT, Director
 Arizona Game & Fish Department
 2222 West Johnny Road
 Phoenix, Arizona 85023
 602-340-3000

ARIZONA GAME & FISH DEPARTMENT
 2222 West Johnny Road Phoenix, Arizona 85023 602-340-3000

July 20, 1984

John O'Leary
 U.S. Army Corps of Engineers
 Environmental Planning
 300 N. Los Angeles St.
 P.O. Box 2711
 Los Angeles, CA 90053-2325

Re: Ephraim Wash

Dear Mr. O'Leary

This letter is in response to your request for information on special status wildlife species that occur in the Ephraim Canyon area of Nogales, Arizona. Species occurrence records that are presently on the Nongame Branch Data Management System are:

- Northern Beardless Tyrannulet (Camptostoma imberbe ridgwayi) - Group 3 on AGFD "Threatened Native Wildlife List."
- Attatched to this letter is a list of special species for the Nogales Wash Flood Control project area that might also occur in Ephraim Canyon. We recommend that a biological inventory should be conducted in Ephraim Wash for threatened, endangered and special status species prior to finalizing a project design.

If we can be of further assistance, please contact our Tucson Regional Office: 602-628-5982.

Sincerely,
 Bud Bristow
 Vashti C. Supplee
 Habitat Evaluation Spec.
 Tucson Regional Office

VCS/hc
 cc: Richard Glinski

Arizona Game & Fish Department

BRUCE BABBITT, Director
 Arizona Game & Fish Department
 2222 West Johnny Road
 Phoenix, Arizona 85023
 602-340-3000

ARIZONA GAME & FISH DEPARTMENT
 2222 West Johnny Road Phoenix, Arizona 85023 602-340-3000

April 25, 1984

Mr. Gilbert Metz
 U. S. Fish and Wildlife Service
 Ecological Services
 2914 W. Fairmount Ave.
 Phoenix, Arizona 85017

Dear Mr. Metz:

This letter is in response to your request for information on the special status species that occur in the area of Nogales-Potrero Wash near Nogales, Arizona. Species occurrence records that are presently on the Nongame Branch Data Management System are:

- Beardless Cinch Weed (Pectis imberbis) - proposed Category 2 species
- Mexican Garter Snake (Thamnophis eques) - Group 3 on AGFD "Threatened Native Wildlife List"
- Desert Hook-nosed Snake (Gyalopion quadrangulatus) - Group 3 on AGFD "Threatened Native Wildlife List"
- Gray Hawk (Buteo nitidus) - Group 2 on AGFD "Threatened Native Wildlife List" will be petitioned for threatened or endangered classification in 1984 or 1985.
- Northern Beardless Tyrannulet (Camptostoma imberbe ridgwayi) - Group 3 on AGFD "Threatened Native Wildlife List"
- Black-bellied Whistling Duck (Dendrocygna autumnalis fulgens) - Group 4 on AGFD "Threatened Native Wildlife List"

Species that likely occur in the area but are not presently on the data management system are:

- Mountain Skink (Eumeces callicephalus) - Group 4 on AGFD "Threatened Native Wildlife List"

-2- April 25, 1984

Mr. Gilbert Hunt
Plains Prairie Warbler Toad (*Gastrophryne olivacea*) -
Grade 4 on AFD "Threatened Native Wildlife List"

Yampi Black-headed Snake (*Tantilla yaguna*) - No official
status, but status is still uncertain

Western Yellow-billed Cuckoo (*Coccyzus americanus*
occidentalis) - Proposed for listing as Category 2.

Chintheilly Bandbird (*Tyrannus carolinensis*) -
Grade 4 on AFD "Threatened Native Wildlife List"

Bonaparte's Woodpecker (*Pichyramphus alainae richardii*) -
Grade 4 on AFD "Threatened Native Wildlife List".

As the U.S. Army Corps of Engineers develops their plan
for the proposed hydroelectric project in the area, we
will have to deal with further reducing the opportunities for
conservation of these resident species.

Sincerely,
Paul Brinkley, Director

Richard L. Gilmer,
Montano Biological

1. Tom Simpson, AFD Tucson /

TELEPHONE OR VERBAL CONVERSATION RECORD		DATE
For use of this form use AD 100-15, the present agency, is the relevant agency's Office		26 July 81
NAME OF CALLER	NAME OF CALLED	NAME OF CALLED
ADDRESS	ADDRESS	PHONE NUMBER AND EXTENSION
OFFICE	OFFICE	PHONE NUMBER AND EXTENSION
NAME OF CALLER	NAME OF CALLED	NAME OF CALLED
ADDRESS	ADDRESS	PHONE NUMBER AND EXTENSION
OFFICE	OFFICE	PHONE NUMBER AND EXTENSION
NAME OF CALLER	NAME OF CALLED	NAME OF CALLED
ADDRESS	ADDRESS	PHONE NUMBER AND EXTENSION
OFFICE	OFFICE	PHONE NUMBER AND EXTENSION

NAME OF CALLER: Jim Giffon

NAME OF CALLED: A.Q. Mirright

ADDRESS: A.Q. Mirright, Engineering Services Section, Santa Cruz Co. because that county has no A.Q. Dept. Construction would probably result in fugitive dust problems. He agreed that CO problems could be minimized by avoiding the winter months. He did not think construction equipment would cause serious incr. CO conc. The real problem is the border crossing and traffic there. He suggested I talk to Carl Billings, Engineering Services Section, regarding the need for a permit.

Carl Billings

No permit would be required during the construction phase because it is a one-time only construction project. Any rock crushing activity on-site would require a permit. Dust controls should be used to keep dust to a minimum.

DA FORM 751

REPLACES EDITION OF 1 FEB 54 WHICH WILL BE USED

REPLACES EDITION OF 1 FEB 54 WHICH WILL BE USED

TELEPHONE OR VERBAL CONVERSATION RECORD		DATE
For use of this form use AD 100-15, the present agency, is the relevant agency's Office		March 13, 1987
NAME OF CALLER	NAME OF CALLED	NAME OF CALLED
ADDRESS	ADDRESS	PHONE NUMBER AND EXTENSION
OFFICE	OFFICE	PHONE NUMBER AND EXTENSION
NAME OF CALLER	NAME OF CALLED	NAME OF CALLED
ADDRESS	ADDRESS	PHONE NUMBER AND EXTENSION
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DA FORM 751

REPLACES EDITION OF 1 FEB 54 WHICH WILL BE USED

REPLACES EDITION OF 1 FEB 54 WHICH WILL BE USED



DEPARTMENT OF THE ARMY
Corps of Engineers
Los Angeles District

March 18, 1987

Office of the Chief
Environmental Resources Branch

Mr. Maurice Besant
District Conservationist
Soil Conservation Service
1141 N. Romero Road
Tucson, Arizona 85705

Dear Mr. Besant:

The Los Angeles District Corps of Engineers proposes construction of flood control features along portions of both Nogales Wash and Potrero Creek in Santa Cruz County, Arizona. Alternatives under consideration include lateral collector channels at the international border with Mexico, a new Potrero Creek diversion channel located between Potrero Creek and Nogales Wash and south of the Chula Vista subdivision, and a formal channel along Nogales Wash as it flows along the east side of the Chula Vista subdivision. The area and alternative plans are outlined on the enclosed maps (enclosure 1). Enclosure 2 is a more detailed description of the project plans.

Also included is form AD 1306, which we are submitting as required by the Final Rule, Farmland Protection Policy Act (7 CFR Part 658), dated July 5, 1984, to initiate the Soil Conservation Service project review process (enclosure 3). Upon receipt of the returned form within 45 days, the Los Angeles District will assess the impacts of the proposed alternatives on prime and unique farmlands and farmlands of statewide and local importance based on the Land Evaluation Criteria/Relative Value score supplied by your office and the Site Evaluation Criteria applied by the Corps. The assessment and completed form will be included in the draft environmental assessment for the proposed project.

In order to meet our schedule dates, we would appreciate your response in as expeditious a time period as practical. If you have any questions concerning the proposed project, please contact Mr. David Castanon, Environmental Coordinator, at (213) 894-0245.

Sincerely,

[Signature]
Carl F. Buson
Chief, Planning Division

Enclosures

DESCRIPTION OF PROJECT ALTERNATIVE PLANS

Lateral Collector Channel:

This portion of the project is located in a heavily urbanized portion of the City of Nogales at the international border with Mexico. In fact, the lateral collector channels will be designed to capture overland flood flows traveling down the streets in the immediate vicinity of the border crossing as they come from Nogales, Sonora into Nogales, Arizona. This portion of the project is not near any farmlands and therefore is not considered further and is not entered on Form AD 1306.

New Potrero Creek Diversion Channel:

This portion of the project will be designed for two levels of protection (100 yr. and 20 yr.). However, at this time, the dimensions of the 20 yr. design are not available. Nonetheless, we will discuss the 100 yr. plan and conservatively assume the impacts of the 20 yr. plan are identical to the impacts of the 100 yr. plan.

This new channel will be designed to take flood flow from Potrero Creek as they emerge from culvert beneath Highway 89, but before they reach the mobile home park (Pete's Kitchen) which lies west of and adjacent to the Chula Vista subdivision. This diversion channel will also capture overland flood flows which have broken out of Nogales Wash and would otherwise flow across a grazed field, then through both Chula Vista and Pete's Kitchen.

As designed, the New Potrero Creek Diversion Channel would consist of a 15 foot deep channel with 2:1 side slopes and a 6 foot high berm (also with 2:1 sloped sides) adjacent to and north of the channel. The southern embankment of the channel would be reinforced with grouted stone. The northern embankment of the channel would be reinforced with riprap. The slopes of the berm will be planted with grass. The total width of both the channel and the berm would average about 154 feet. The channel length is 800 feet in an east-west direction. Thus, the channel and berm will permanently occupy an area of 2.83 acres (154 ft. by 800 ft.). An area of approximately 1.84 acres (100 ft. by 800 ft.) would remain behind (north of) the berm. This remaining parcel of what previously was a grazed field, would now become developable due to its removal from the floodway. It is possible that this site could be converted into a recreational park or residential neighborhood.

Formal Nogales Wash Channel:

Where the New Potrero Creek Diversion Channel meets Nogales Wash, it will tie into the Formal Nogales Wash Channel. This formal channel has vertical concrete sides and a 65 foot concrete bottom. The length of this channel is 1450 feet. At the end of the formal channel, an energy dissipating structure is planned.

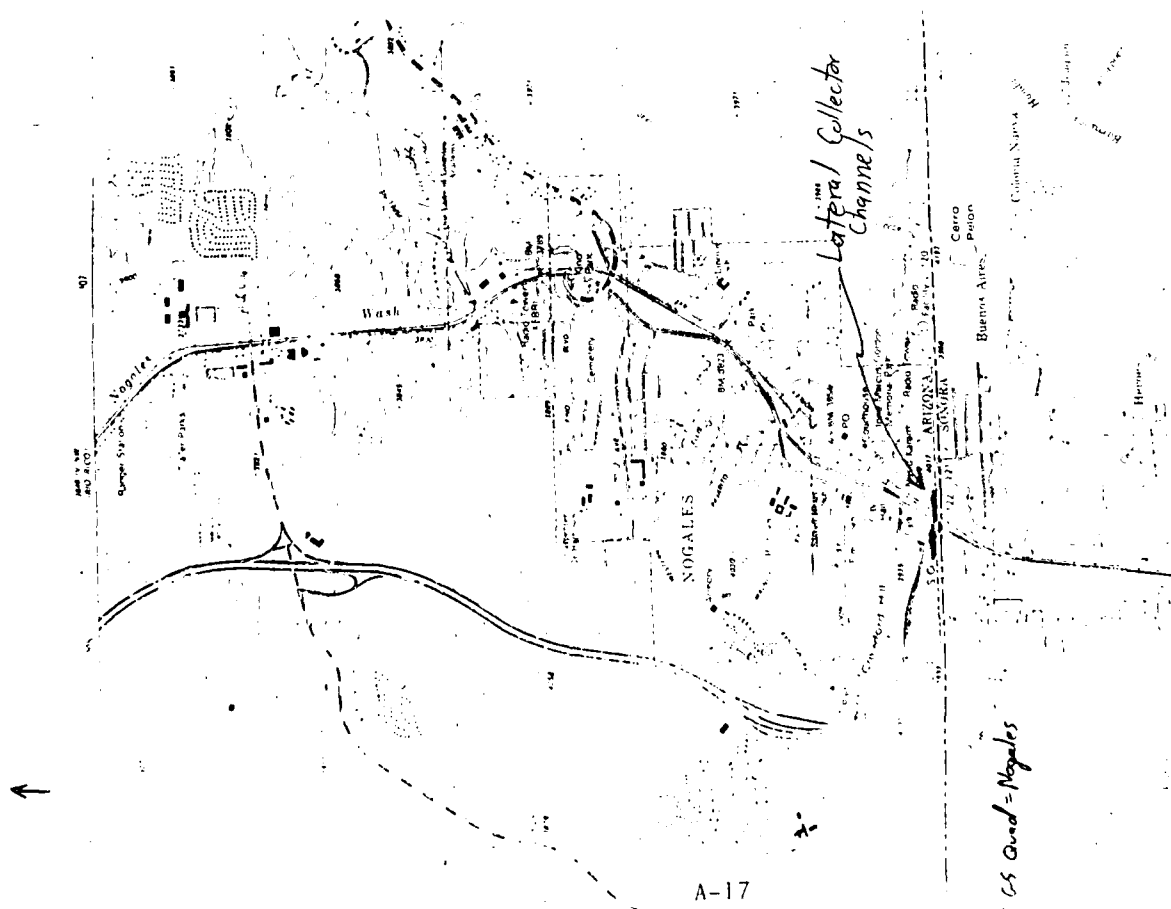
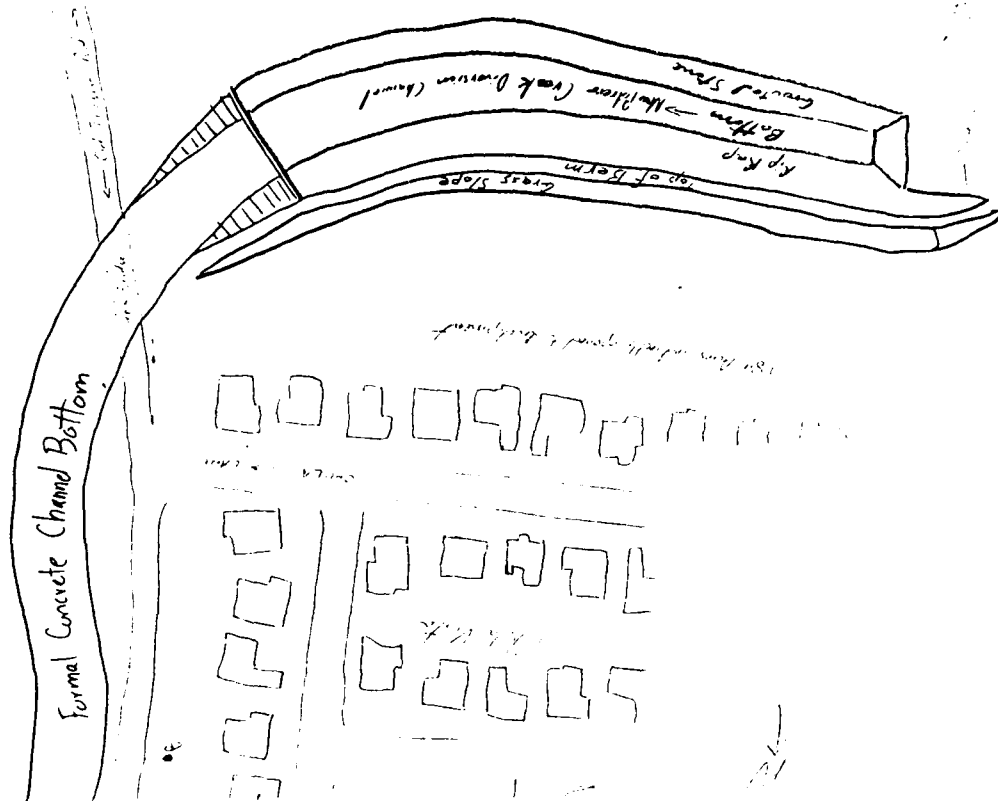
Encl. 2

The energy dissipator at its upstream end ties into the formal channel and thus will have vertical walls with a 65 foot channel width. However, over a distance of 450 feet, the structure will widen to 150 feet and the walls will taper out to near horizontal. For an additional 600 feet downstream, both banks of the channel will be excavated to the 150 foot width. The total "footprint" of the formal Nogales Wash Channel, its energy dissipator, and additional channel wall excavation has been calculated to be 5.77 acres.

If you have any questions, please do not hesitate to call:

Mr. David Castanon at (213) 894-0245.

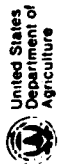




Site A = New Paterson Creek Diversion Channel
 Site A = Berm next to New Paterson Creek Diversion Channel
 Site B = Formal Concrete Negales Wash Channel
 Site B =

Site A =





Soil
Conservation
Service

Tucson Field Office
3241 N. Romero Road
Tucson, Arizona 85705

Study on High Feasibility Study

Date March 25, 1987

Carl F. Dixon
Chief, Planning Division
Department of the Army
Los Angeles District, Corps of Engineers
P.O. Box 271
Los Angeles, California 90003-2705

File code

Referenced in the completed AD-1000 Farmland Conversion Rating Sheet
and the Feasibility and Availability Study.

Site A: 1,000 ac. of prime farmland will be directly or
indirectly converted

Site B: 23.0 acres directly or indirectly converted
since most appears to be in an existing channel
also enclosed in the calculation sheet that was used and the sources
of information are noted.

Thurman J. Connerly
Thurman J. Connerly
District Conservationist

The Soil Conservation Service
Department of the Army
Washington, D.C. 20319

50

Highland West Feasibility Study

Prime farmland

Sited:

acres in county

800 (West Side)

460

Agricultural
Group

3

% to
channel - soil

100%

Prime farmland

Directly Indirectly converted 467 ac

Site B:

most of Site B is existing work
therefore none of Site B was considered prime farmland

Total acres converted (Prime farmland) - 467 ac
 $467 \text{ ac} \div 47048 \text{ ac total} = 0.00115\%$

Farmland Agricultural group acres

1 - 1200

2 - 2410

3 - 460

total 4070

$4070 \div 4070 = 100\%$

Same or higher value

Relative Value: 81

taken from worksheet 2: Santa Cruz County

taken from worksheet 1:
Santa Cruz County

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT COMDT OF EDUCATION



June 9, 1987

Office of the Chief
Environmental Resources Branch

Mr. Maurice Bossuyt
District Conservationist
Soil Conservation Service
3241 N. Romero Road
Tucson, Arizona 85705

Dear Mr. Bossuyt:

This letter updates my letter to you dated March 18, 1987 regarding Farmland Protection Policy Act coordination for our Nogales Wash flood control project. A new impact area has been added to this project that might affect farmlands in the area. Our engineering design for the flood control channel has resulted in the realization that approximately 127,000 cubic yards of excess fill material will need to be disposed of at some location. Coordination with local concerns has resulted in the decision to place the fill material at the location shown in the enclosed map (enclosure 1). This site is located north and south of Old Tucson Road as it crosses Potrero Creek .70 miles north of the Chula Vista subdivision.

The landowner currently uses this location to graze cattle and horses. Placement of the fill material over approximately 50 acres will raise the surface about 1.6 feet. The landowner plans to utilize this area for more intensive agriculture after the fill has been deposited. Thus, the fill material will not be compacted. No fill material will be placed in the Potrero Creek floodway, Pescuiera Wash, or any other side tributaries.

I am resubmitting AD 1006 as required by the Final Rule, Farmland Protection Policy Act (7 CFR Part 658), dated July 5, 1984 to continue the Soil Conservation Service project review process (enclosure 2). Upon receipt of the returned form within 45 days, the Los Angeles District will assess the impacts of the proposed alternatives on prime and unique farmlands and farmlands of statewide and local importance based on the Site Evaluation Criteria/Relative Value score supplied by your office and the Site Evaluation Criteria applied by the Corps. The assessment and completed form will be included in the environmental assessment for the proposed project.

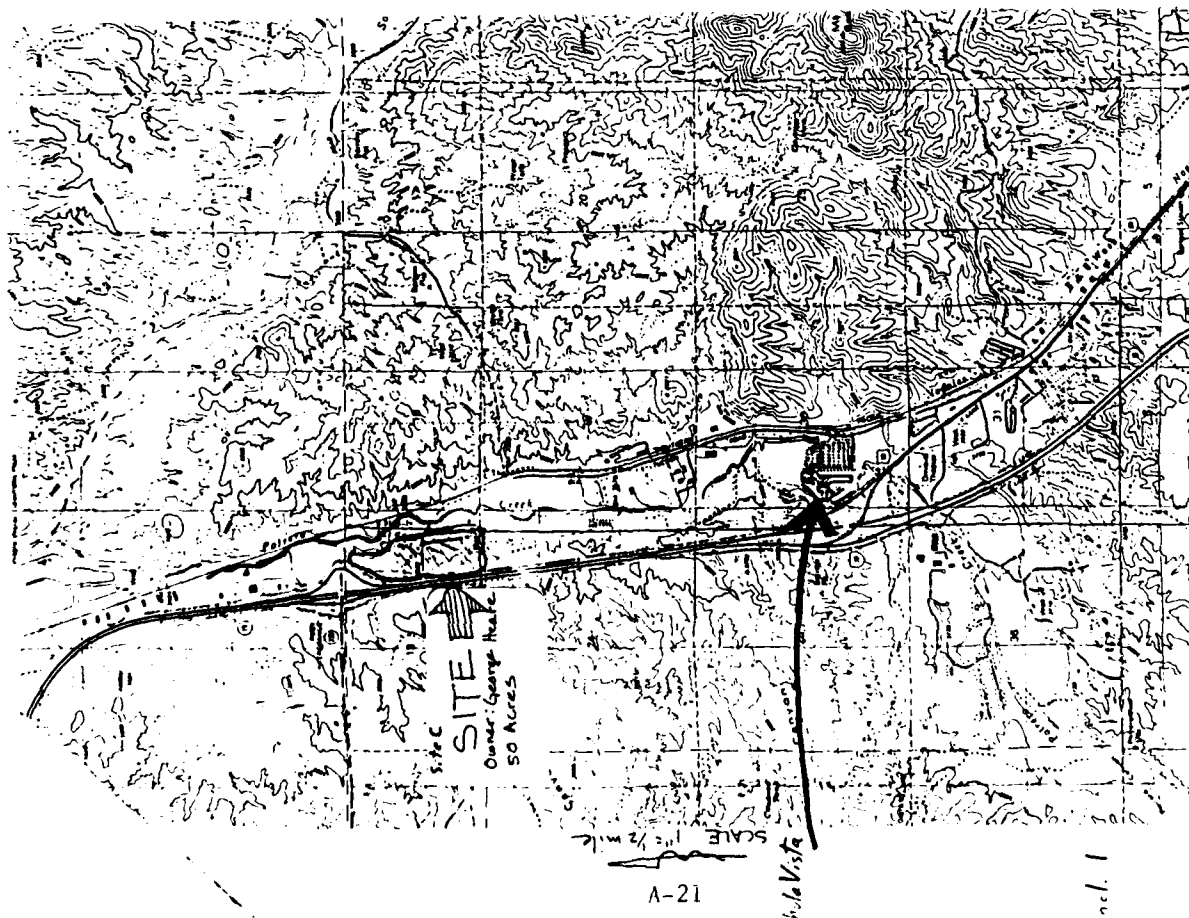
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In order to meet our schedule dates, we would appreciate your response in as expeditious a time period as practical. If you have any questions concerning the proposed project, please contact Mr. David Castanon, Environmental Coordinator, at (213) 894-0245 or FTS 789-0245.

Sincerely,

Robert S. Jones
Robert S. Jones
Chief, Planning Division

Enclosures



June 24, 1967

To: Mr. Maurice H. Supt.

From: Mr. David C. Larson

Re: Additional information regarding disposal material and disposal site for the Nodules Wash Flood Control Channel.

The following information should answer most of the questions you had regarding the disposal site and the disposal of material as well as the current status of the disposal site.

Nature of the Disposal Materials:

The Corps' Draft Feasibility Study Geotechnical Appendix discusses "Foundation Conditions" along the proposed channel. In the section on Nodules Wash, the report states:

"...The streambed width varies from 15 to 100 feet in this reach. Streambed materials consist mostly of fine to coarse sands with zones of gravel, cobbles and boulders. Approximately 15 percent of the surface materials are larger than 3 inches, with maximum sizes generally less than 2 feet but occasionally a single or 6 feet in diameter. The bank materials are predominantly older alluvium, consisting of brown sandy silts and silty sands with varying amounts of gravel, and occasionally overlain by a thin layer of dark gray organic clay. This older alluvium is exposed intermittently in the stream channel throughout the downstream half of the section, reaching thicknesses as great as 10 feet in the banks. Senses and beds are scattered to densely packed granitic and volcanic boulders, reaching sizes of 3 feet or more in diameter in this unit. Nodules formation bedrock is exposed along the channel for about 100 feet at the upstream end of the study reach, ... and for 600 feet one mile downstream ... Bank exposures reach 4 to 5 feet above the streambed in both locations. Bedrock was encountered in borings along a 600-foot stretch of the sewage pipeline 2 miles downstream from the beginning of the study reach, and it is likely that the top of rock lies close to streambed elevations in this area. Much of the bank material is highly erodible and various bank protection methods have been utilized, including reinforced concrete, pile and sheet piling, and armorings with stone and concrete caping. Many portions have failed due to undercutting, erosion

around the ends of the structures, and from flows
 section behind the bank protection. The proposed
 section creek channel is located near the downstream
 of reach 4B [at the Chula Vista Community], and
 will extend across the common floodplain of Nogales
 Wash and Poirere Creek. No subsurface data are
 available in this area, however, surface materials
 consist of moderately plastic silty sands with
 relatively small amounts of gravel and cobbles. The
 groundwater table is estimated to be at a depth of
 about 10 feet."

Current Use of the Disposal Site

The disposal site (approx. 50 acres) is owned by Mr. George
 Krupp. He currently uses it to raise and train horses. After
 years of this use the area has become rather compacted and dusty.
 According to Mr. Frank Krupp (Director of Santa Cruz County
 Planning and Zoning, Public Works, and Flood Plain & Flood
 Control District), Mr. Krupp feels that disposal of the excess
 fill material will not adversely affect his operation and that it
 might improve conditions. No irrigation system is in place at
 the present time. Mr. Krupp (according to Mr. Krupp) plans to
 continue his horse raising and training operation after the fill
 material has been deposited.

Additional information regarding the current and future uses
 of the above property can be obtained from Mr. Krupp. His office
 is in Nogales and he can be reached at 287-2211 or 287-4779.

David Castanon
 Environmental Coordinator
 Los Angeles Dist.
 Co. of Engineers
 (213) 894-0245

TELEPHONE OR VERBAL CONVERSATION RECORD		DATE
For use of this form, see AD 340-15. Use appropriate agency in the Address column's Office.		7-6-87
SUBJECT OF CONVERSATION		
Prime and Unique Faralands		
PERSON CALLING	INCOMING CALL	PHONE NUMBER AND EXTENSION
Don Mather	Address Soil Conservation Service-Tucson	(602)
PERSON CALLED	OFFICE	PHONE NUMBER AND EXTENSION
David Castanon	USACOE-Los Angeles	(213) 894-0245
PERSON CALLING	OUTGOING CALL	PHONE NUMBER AND EXTENSION
	OFFICE	
PERSON CALLED	ADDRESS	PHONE NUMBER AND EXTENSION
SUMMARY OF CONVERSATION:		
<p>Don called to clear up some issues on the Prime and Unique Faralands coordination. Don had visited the proposed disposal site after receiving the COE's letter of 6/9/87. Don indicated that he saw an irrigation ditch leading away from a well. Don was not sure whether this rudimentary irrigation system qualified as an irrigation system under Arizona's Groundwater Management Act of 1980. The issue is important as one of the criteria for designation of "Prime and Unique" farmland is that it have an irrigation system. I suggested we conservatively assume that this 50-acre disposal site was irrigated (and, thus, Prime and Unique). Don agreed to discuss this issue in the cover letter he was preparing in response to the Corp's letter of 6/9/87.</p> <p>We also discussed another slight change in the project since the Corps sent the first letter to SCS on 3/18/87. In that first letter the project description indicated that the CVC would end along Nogales Wash just on the north east corner of Chula Vista. However subsequent design changes had the CVC ending further downstream at the confluence of Nogales Wash and Chula Vista. As such, direct impact to farmlands would still be negligible as the alignment still coincided with that for Nogales Wash. However, indirect impacts would increase as the open lot on the north side of Chula Vista would now be removed from the Flood plain and rendered this developable. I suggested to Don that we simply agree over the phone as to the added impacts. Hence, we agreed that this change would add _____ acres of indirect impacts to Prime and Unique Faralands. We also agreed that this Telephone Conversation Record would serve as a record of this coordination.</p>		

DA FORM 751

REPLACES EDITION OF 1 FEB 58 WHICH WILL BE USED
 U.S. G.P.O. 1982-564-038/0377



United States
Department of
Agriculture

Soil
Conservation
Service

Tucson Field Office
3241 N. Romero Rd
Tucson, AZ 85705

-2-

Site: Site C - Nogalas Wash Feasibility Study Date: July 7, 1987

File Code

David Castanon
Environmental Coordinator

The Arizona Department of Water Resources did a study titled, "The Preliminary Project Evaluation - Potrero Creek Flood Control Project - Santa Cruz County, Arizona" for the Santa Cruz County Flood District. The report was dated July, 1983.

I have enclosed soil maps covering both the Chula Vista site and the Heare fill site, maps and booklet on prime farmlands in Santa Cruz County, and a list of soils in Santa Cruz County that are considered prime. Also, enclosed is the Site C calculation sheet with sources noted.

M. R. Walther (Holding)

Maurice Bossuyt
District Conservationist

Enclosed are your copies of the AD-1006, Farmland Conversion Import Rating sheet for the Nogalas Wash flood control project. Sites A and B were addressed previously. As per the phone conversation with David Castanon on July 6, 1987, it was assumed that the extension of the bank work along Potrero Creek to the confluence with Nogalas Wash would remove slightly more prime farmland than originally planned open for development.

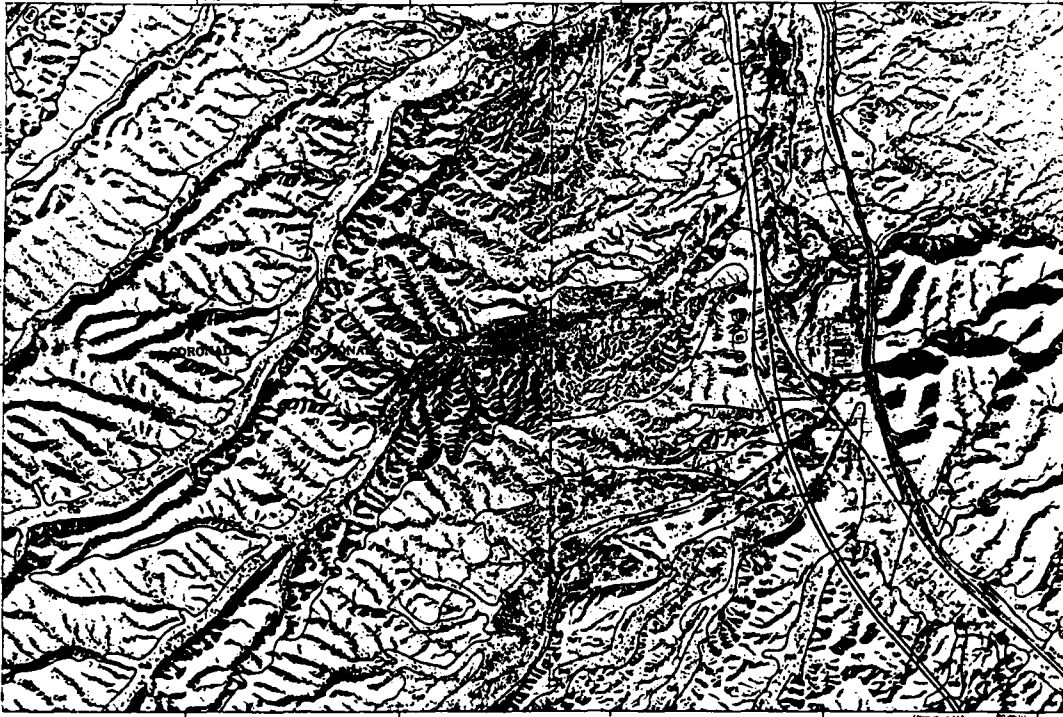
In reviewing the proposal for Site C - the proposed 50 acres fill area on the George Heare Farm, I would like to make the following comments.

Since our soil surveys only deal with a 60" profile, the area where the excavation is being made and the area where the excess fill is placed (G. Heare Farm) both have similar soils. If excess fill is obtained from below this 60" profile, it would be impossible to predict how the resulting soil would be classified. From the supplemental material you provided us from your Geotechnical Appendix, the source of fill material does not sound that good. For that reason, I stated that all of the prime farmland in Site C (29 acres or the total 50 acres) would be converted to non-prime farmland.

My other comment is that you stated that Mr. Heare raises and grazes horses on this property and would like to increase the intensity of his operation. Also, you stated there was no irrigation system in place.

One of the criteria for prime farmland in Arizona is that the land have a source of irrigation water. I did see a well and a dirt ditch in place along the south edge of the south field. I do not know if the well is being used or not as the ground looks pretty irregular for irrigation. If his plans for a more intense operation include irrigation, he should be sure he has irrigation water rights for that land. This farm is located in the Tucson Active Management Area, 370 S. Meyer, Tucson Arizona, 85701 would be the agency Mr. Heare should contact to be sure he has water rights.





Regulation Work Project - Site C

Area	Area in acres	Area in acres	Area in acres
Site C (see sketch)	1300	2	32%
Site (see sketch)	460	3	26%
			58%

Total area (from) to be converted.

2.9% = 47.18% total farmland: 0.00063

Area in Acres	Area in Acres	Area in Acres
1 - 1300 ac	2 - 2410 ac	3 - 460 ac
		4070
		4070 = 4070 = 100%

Area in Acres	Area in Acres	Area in Acres
1 - 1300 ac	2 - 2410 ac	3 - 460 ac
		4070
		4070 = 4070 = 100%

2.9% = 47.18% total farmland: 0.00063

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1 - 1300 ac	2 - 2410 ac	3 - 460 ac
		4070
		4070 = 4070 = 100%

2.9% = 47.18% total farmland: 0.00063

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I (To be completed by Federal Agency)		Date Of Land Evaluation Request	
Name Of Project		Federal Agency Requested	
Project Title		County And State	
Channelization And Barr Construction		Santa Cruz County, Arizona	
PART II (To be completed by SCS)		Date Request Received By SCS	
Does the site contain prime, unique, statewide or local important farmland?		Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
If no, the FPPA does not apply -- do not complete additional parts of this form.		Acres Impaired	
Name Of Local System Used		Average Farm Size	
PASTURE, SAN CARLOS, ALFALFA		47048	
Name Of Local System Used		Amount Of Farmland As Defined In FPPA	
LESA		Acres: 47048 % 100	
Date Land Evaluation Returned By SCS		Date Land Evaluation Returned By SCS	
MARCH 25 1987		MARCH 25 1987	
PART III (To be completed by Federal Agency)		Alternative Site Rating	
A. Total Acres To Be Converted Directly		Site A	
B. Total Acres To Be Converted Indirectly		Site B	
C. Total Acres In Site		Site C	
PART IV (To be completed by SCS) Land Evaluation Information		Site D	
A. Total Acres Prime And Unique Farmland		4.67	
B. Total Acres Statewide And Local Important Farmland		-	
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted		0.0009%	
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value		100	
PART V (To be completed by SCS) Land Evaluation Criterion		Relative Value Of Farmland To Be Converted (Scale Of 0 To 100 Points)	
PART VI (To be completed by Federal Agency)		Maximum A Points	
Site Assignment Criteria (If these criteria are explained in 7 CFR 658.510)		15	
1. Area In Nonurban Use		10	
2. Perimeter In Nonurban Use		10	
3. Percent Of Site Being Farmed		10	
4. Protection Provided By State And Local Government		20	
5. Distance From Urban Builtup Area		20	
6. Distance To Urban Support Services		0	
7. Size Of Present Farm Unit Compared To Average		10	
8. Creation Of Nonfarmable Farmland		25	
9. Availability Of Farm Support Services		5	
10. On Farm Investments		20	
11. Effects Of Conversion On Farm Support Services		25	
12. Compatibility With Existing Agricultural Use		10	
TOTAL SITE ASSESSMENT POINTS		160	
PART VII (To be completed by Federal Agency)		Relative Value Of Farmland (From Part VI)	
Total Site Assignment (From Part VI) House in a line of		100	
Total Site Assignment (From Part VI) House in a line of		160	
TOTAL POINTS (Total of above 2 items)		141	
Date Of Selection		8-10-87	
Was A Local Site Assignment Used?		Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	

Non significance of Impacts

Encl. 2

APPENDIX B

FISH AND WILDLIFE COORDINATION ACT REPORT



**UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES**
3616 W. Thomas, Suite 6
Phoenix, Arizona 85019

February 11, 1988

Colonel Tadahiko Ono
District Engineer
U.S. Army Corps of Engineers
P.O. Box 2711
Los Angeles, California 90053-2325
Dear Colonel Ono:

This is our fish and wildlife report on effects of the proposed Nogales Wash Flood Control Project in Santa Cruz County, Arizona. It has been prepared under authority of and in accordance with Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). This report has been developed in coordination with the Arizona Game and Fish Department (AGFD) and has their concurrence as evidenced by the enclosed copy of their letter dated March 12, 1987.

Project data were obtained from maps, descriptions and reports provided by Corps of Engineers (Corps) personnel from the Los Angeles District. The Corps began investigations in the Nogales area during October 1983 with an examination of erosion and inundation areas along the Nogales Wash. By September 1984, a complete Reconnaissance Phase study was under way and the Feasibility Phase was initiated in April 1985. The Fish and Wildlife Service (Service) provided the Corps with a Planning Aid Report on the existing environment of Nogales Wash in July 1984. Field work for a Habitat Evaluation Procedure (HEP) was completed in April 1986. Specific project sizing information and results of the HEP report were provided in the Corps draft Feasibility Report and draft Environmental Assessment in August 1987.

DESCRIPTION OF THE PROJECT

The proposed project would be located within and north of the City of Nogales in Santa Cruz County, Arizona (Figure 1). Two water courses, Nogales Wash and Potrero Creek, were involved in the development of project alternatives. The main flooding problem within the project area is urban runoff that flows across the international border from the City of Nogales, Sonora, Mexico. Storm drains and other urban flood control measures in Nogales, Sonora, are not adequate to capture storm runoff and prevent street flooding in Nogales, Arizona. Other problems concern flooding in existing wash channels and the presence of residential developments in the flood plain.

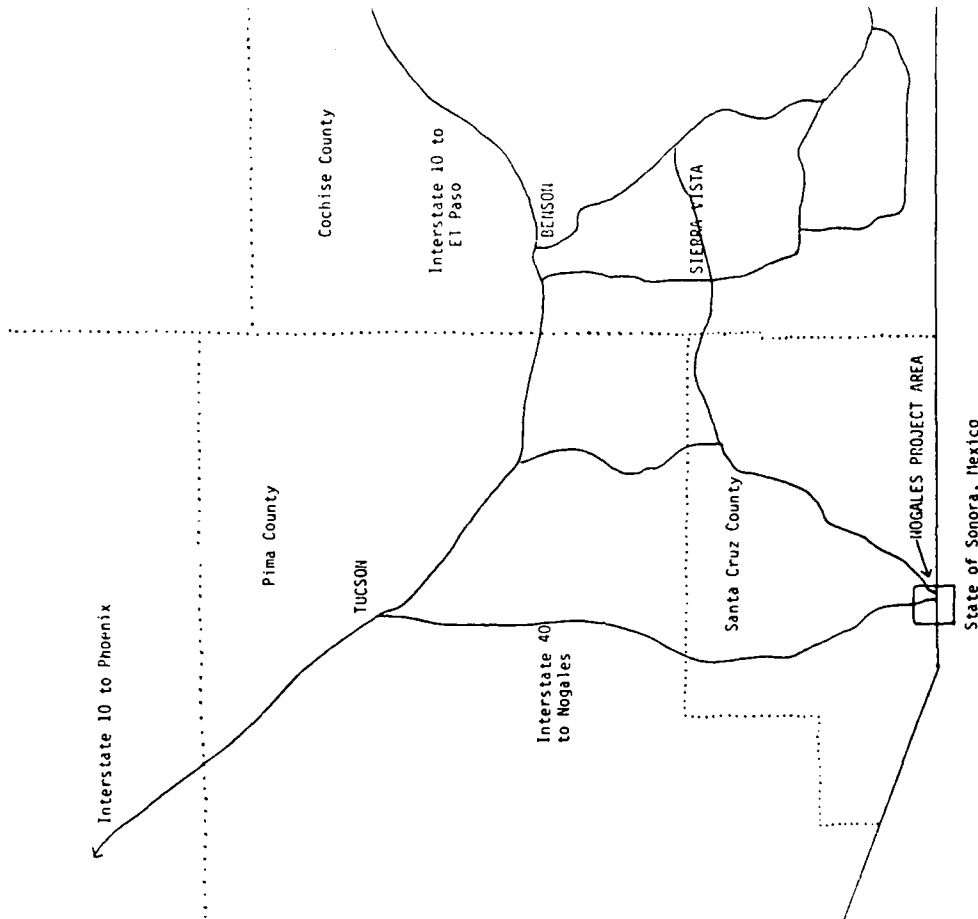
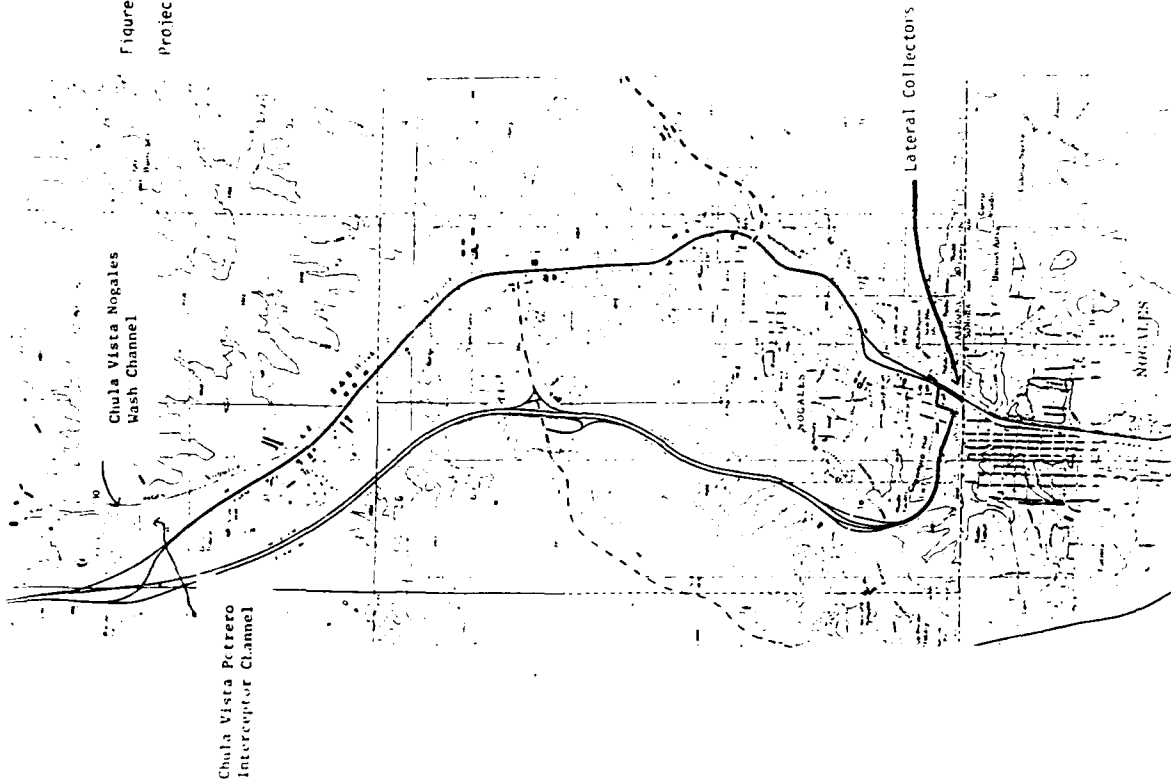


Figure 1 General project area

Figure 2
Project Area



Several alternative plans that address flooding and erosion problems along Nogales Wash and Potrero Creek have been developed since 1984. The Corps preferred action is a combination of two features to capture urban runoff (Figure 2). The plan also contains a flood warning system for the drainage basin.

Feature 1

The first feature would utilize two 900-foot lateral collector channels constructed adjacent and parallel to the border on the Arizona side with one on each side of Nogales Wash. The lateral collectors would capture the overland flows and convey them to the existing Nogales Wash channel. This feature is described more fully in the draft Feasibility Report.

Feature 2

The second feature would involve two inter-related components collectively named the Chula Vista Channels (CVC) (Figure 3) to protect the Pete's Kitchen mobile home park and Chula Vista subdivision. The CVC would intercept the 125-year present condition and 100-year future condition flood flows from Nogales Wash and Potrero Creek and convey the flows around the residential areas and discharge them back into Nogales Wash north of the residences.

The Chula Vista/Potrero intercepter channel (CVPIC) would be a 692-foot long grouted-stone channel and levee with a trapezoidal cross section. The CVPIC would tie into a hill which forms the west valley boundary and would extend eastward to empty into Nogales Wash. This channel would have a base width varying from 30 to 60 feet. The south side slope height of the channel would vary from 10.5 to 13.6 feet, and the north side slope height of the channel would vary from 19 to 22 feet. The levee would vary in height above the existing ground surface from about 5.1 to 12.1 feet and have a top width of 15 feet. The channel (including a 2-foot deep cutoff along the north side) and the levee (including the top and outside slope with a 10-foot deep toe) would be completely revetted with a 12-inch thick layer of grouted stone. All side slopes would be 1 vertical on 2 horizontal.

Downstream of the CVPIC inflow, the Chula Vista/Nogales Wash Channel (CVNWC) would be a 1,429-foot long concrete channel with a rectangular cross section, except for the transitions at the upstream and downstream ends, that would convey flows from the CVPIC along the east side of Chula Vista. The CVNWC would have an inside width of 65 feet within the rectangular portion and wall heights ranging from 11 to 21.5 feet. Berm widths on both sides of the channel would be 15 feet, and cut and fill slopes would be 1 vertical on 2 horizontal. A 6-foot high chain-link safety fence would be required on top of the channel walls.

Below the CVNWC, a 450-foot long grouted stone outlet structure with a trapezoidal cross section would function as an energy dissipator. This

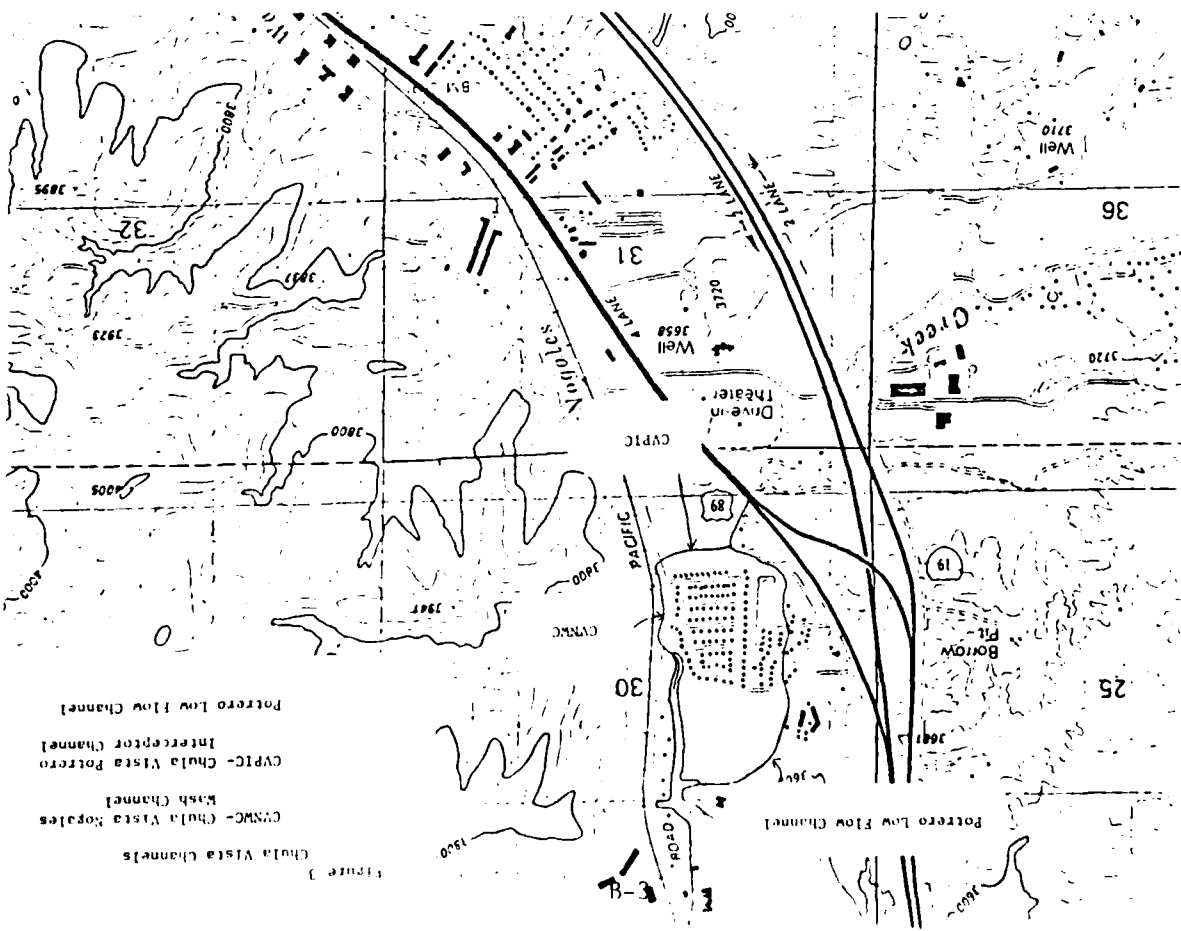


Figure 3
Chula Vista Channels
CVPIC-Chula Vista Potrero
Interceptor Channel
Potrero Low Flow Channel

reach would have a base width varying from 65 to 150 feet and wall heights varying from 8.5 to 18 feet. It would have 15-foot wide berms on each side and 1 vertical on 2 horizontal side slopes. The channel would be revetted with an 18-inch thick rough grouted rock layer.

Below the energy dissipator, an 800-foot long unlined channel with a trapezoidal cross section would function as an outlet to the natural streambed of Nogales Wash. This reach would have a base width varying from 150 to about 20 feet at the downstream end where it would daylight with the existing streambed. Side slopes would be 1 vertical on 2 horizontal.

The normal flow of Potrero Creek would not be diverted into the CVPIC but would continue to flow in the existing streambed through the Pete's Kitchen subdivision to the confluence with Nogales Wash downstream of the project area. This is referred to as the Potrero Low Flow Channel.

EXISTING ENVIRONMENT

Aquatic and Terrestrial Resources

The Nogales Wash Study area comprises a 94-square mile drainage basin. Nogales Wash rises in Mexico and flows north through the cities of Nogales, Sonora and Nogales, Arizona. Nogales Wash flows into Potrero Creek approximately 5 miles north of the International Boundary and Potrero Creek flows north into the Santa Cruz River approximately 9 miles north of the boundary.

The project area is highly developed, ranging from dense urbanization at the border to industrial and residential development further north. At the border, Nogales Wash is contained in a .75 mile covered concrete channel followed by a 1.25 mile open concrete channel. This channel was constructed in the 1930's by the International Boundary and Water Commission. Below this channel, the wash channel is earth with occasional gabions for approximately 2 miles. Evidence of past channelization work exists below the railroad bridge near North Valley Verde Circle. The concrete lining is in varying states of repair along both banks, ranging from areas of complete erosion to areas in good condition. This channel is old, as evidenced by the growth of large trees in the concrete slabs, and extends to the intersection of Old Tucson Road and Highway 89.

Nogales Wash is confined to a narrow channel below this point with areas of riprap and gabions protecting the railroad track and Old Tucson Road crossing at Chula Vista. The west bank at Chula Vista has been protected by soil cement and gabions from Chula Vista north to the Santa Cruz confluence.

Nogales Wash has a wider channel from Chula Vista north to the Santa Cruz confluence. Local flood protection and erosion control is provided primarily by jacks and riprap. There is much less urbanization along this lower reach.

Potrero Creek crosses a golf course and a pasture before entering the project area at the Highway 89 bridge. A small creek dam immediately downstream of the bridge creates a small pond used for livestock watering. The creek curves north around a bluff, flows in a small defined channel through Pete's kitchen, and then flows along the edge of a pasture before joining Nogales Wash downstream of Chula Vista.

Cover type mapping of riparian vegetation along Nogales Wash and Potrero Creek was accomplished in 1986 for the HEP study. Despite the extent of urbanization in the study area and past flood control activities, Nogales Wash supports a considerable amount of native riparian vegetation. The HEP team identified four different types of riparian habitat along the wash and creek.

The first type is characterized by Mexican elder (*Sambucus mexicana*) in pure stands, usually in long rows along the channel banks. This type is noted in areas further upstream.

Mexican elder is also a common component of the second type which is Mexican elder in combination with mesquite (*Prosopis* sp.) and willow (*Salix* sp.). This type occurs along the entire length of the study area.

The third type is mesquite found in the middle and especially lower reaches. Several areas of closed canopy mesquite bosque exist along Nogales Wash and Potrero Creek along some downstream sites and adjacent to the Old Tucson Road.

The fourth type is cottonwood-willow, dominated by cottonwood (*Populus fremontii*). The active establishment of young cottonwood trees along most of Nogales Wash is rare in southern Arizona. Protection from livestock grazing and the presence of surface water enables good growth. Trees that survived after the 1983 floods are nearly 25 feet tall in some areas. In addition, large cottonwoods form a gallery forest at some downstream locations, and large trees are also scattered up and down the banks and in the channel itself.

Wildlife values of the project area are closely associated with the riparian zone. In the more urbanized sections, the trees and ground cover provided by the riparian zone often provide the most diverse habitat. In the less urbanized sections, the cover and water attract wildlife from the adjacent grasslands as well as supporting a riparian fauna. The lesser degree of human impact is also a significant feature.

The more structurally diverse cottonwood-willow type is the most important wildlife habitat due to the presence of a higher diversity of food and cover sources. Differences in vegetative heights, presence of tree boles, canopy cover, and other structural features enable more species to find cover and food resources. This was demonstrated by the breeding bird survey conducted in 1986 (Groschupf 1986). In this Corps funded study, the

gallery cottonwood and young cottonwood sub-types had the greatest number of bird species (39 and 32 respectively). The mesquite bosque survey recorded 27 species and the mixed riparian (including Mexican elder) had 26 species. The HEP analysis indicated that the latter types lacked 2 of the 6 habitat elements, canopy cover over 25 feet tall and tree boles, that were present in the cottonwood-willow type. A list of birds recorded in the study is presented in Appendix 1.

No surveys for mammals, reptiles, amphibians or fish were conducted in the project area. It would be expected, based on data from other southern Arizona riparian areas, that the fauna would contain a diversity of animal species. A representative list is presented in Appendix 2.

Potrero Creek is a perennial stream fed by several springs in its upper reaches. Nogales Wash is not spring fed, however, there is usually some flow in the channel resulting from street drainage and sewage leakage from Nogales, Sonora. The wash is posted by the Health Department because of the sewage contamination. There is no recreational fishing in either Potrero Creek or Nogales Wash and the only fish species known to be present is the long-fin dace (*Agosia chrysogaster*). Other aquatic resources are extremely limited.

Special Status Species

No federally listed threatened or endangered species occur in the project area. It is possible that peregrine falcons (*Falco peregrinus anatum*) and bald eagles (*Haliaeetus leucocephalus*) may use the area during winter migrations.

The AGFD maintains a computerized system of species occurrence records on special status plant and animal species. Species in the system include federally listed, proposed, and candidate species under the Endangered Species Act and species on Arizona's Threatened Native Wildlife List. Appendix 3 lists those species that have been recorded from the Nogales Wash area or that are likely to occur in that area. Category 2 candidates are those species that have been published in a Notice of Review in the Federal Register for which the Service does not have sufficient information at this time to support their being listed as threatened or endangered. Group 3 species are those that the State of Arizona has determined that their continued presence in the state could be in jeopardy in the foreseeable future. Group 4 species are those species with moderate threats to their habitats which, if threats increased, would qualify for Group 3 status.

FUTURE WITHOUT THE PROJECT

If the Corps does not construct the proposed project, it can be expected that the City of Nogales and Santa Cruz County would continue to seek

federal sponsorship of projects in the Nogales Wash/Potrero Creek area to address flooding and erosion problems. The Soil Conservation Service (SCS) has constructed two projects under Section 716 of the Emergency Watershed Protection Act approximately one mile downstream of the CVC at the Firestone Gardens Subdivision. The SCS projects involved the use of jacks in association with cottonwood and black willow pole plantings to stabilize banks and prevent erosion. Other small projects under Section 205 of the Flood Control Act of 1949 or other authorities may be implemented; however, none are being currently planned. No SCS projects have been completed in the CVC area. These projects would involve federal funding and be required to address mitigation for losses of fish and wildlife resources.

Private, local, county, and state funded actions to address flood and erosion control problems may also be implemented in the project area. Some of these actions may be under the jurisdiction of Section 404 of the Clean Water Act which regulates the placement of fill in waterways. Mitigation for losses of habitat from such activities is a common conditional requirement included in Corps permits issued under Section 404.

Continued flooding and erosion along Nogales Wash and Potrero Creek is likely to remove some of the existing riparian vegetation. In some areas, natural regeneration may replace some of these losses and planting by SCS at Firestone Gardens will provide more replacement acreage. Regeneration within the streambed may not be able to produce a mature riparian stand due to effects of subsequent floods, but widening of the channel due to erosion may result in slower flows that would not scour the channel. Overall, the Service believes that without the project, riparian habitats would be maintained at some level along the Nogales Wash/Potrero Creek drainage.

FUTURE WITH THE PROJECT

Construction of the proposed project features would result in losses of riparian vegetation and potential habitat areas. These losses are discussed below for the specific project features.

Lateral Collection Channels

This feature would be exclusively located in an urbanized area and would not directly affect any fish and wildlife resources. The Corps states there would not be any increase in downstream flows in Nogales Wash due to this feature.

Chula Vista Channels

Construction of the new CVPIC would not impact significant riparian resources. Maintenance of the present channel for normal flows would preserve the large cottonwoods that exist in the Pete's Kitchen area, and riparian vegetation in the field north of the trailer park.

Construction of the new CVPIC channel to accommodate flows from the new CVPIC would result in significant losses of mesquite, cottonwood and willow (Table 1). The concrete lining would permanently remove all riparian vegetation from the banks and floor of the wash and prevent regeneration of vegetation from occurring for the 1878-foot length of the concrete and stone channel. Vegetation would not likely return to the 800-foot outlet area due to the design of the structure and rate of water flow that occurs there.

Completion of the CVC would remove approximately 25 acres of undeveloped, flood prone land from the floodplain. This area is largely confined to the pasture north of the residential area that Potrero Creek flows through. This parcel may be subject to development in the future due to protection afforded by the project.

Although Santa Cruz County has not expressed interest in extending the CVPIC bank protection up or downstream, this may occur in the future. Those projects and their associated impacts would likely be addressed with under Section 404 of the Clean Water Act.

Special Status Species

Some habitat for the resident special status species listed in Appendix 3 would be lost due to project features. No federally listed species would be affected.

DISCUSSION

Loss of 5.98 acres of riparian vegetation would be the major impact of the project on fish and wildlife resources. We consider the cottonwood-willow and mesquite habitats in the project area to contain habitat of high value for evaluation species that is relatively scarce in the ecoregion. Our mitigation goal for this resource is no net loss of in-kind habitat value.

Riparian habitat in Arizona has declined significantly in total acreage within recent years. It is estimated that less than 10% of the original riparian habitat exists along the Colorado River (Omar et al 1977) and only 5% of the Lower Gila Valley riparian habitat still exists (Lacey et al 1975). In the San Pedro River Valley, 50% of the riparian habitat disappeared in 25 years (Lacey et al 1975). The mesquite bosques along the Santa Cruz River south of Tucson have largely been eliminated. Declining water tables, arroyo cutting, fuel wood harvest and grazing are some of the causes for these significant losses.

The reduction of riparian habitat has had significant adverse effects on the wildlife that utilize these areas. Many desert habitats are structurally simple and do not provide enough habitat diversity to support a varied fauna. Using the "Habitat Suitability Index Models: The Arizona Guild and Layers of Habitat Models" (Short 1984) as a measure of comparison, a creosote-bur sage habitat supports only three habitat layers (terrestrial, understory and midstory) as compared to six for a cottonwood gallery forest (aquatic, terrestrial, understory, midstory, canopy and tree boles). The model uses a complex riparian habitat like the cottonwood gallery as the standard for all comparisons since it is the most structurally diverse vegetation type in Arizona. These complex habitats provide more niches and can support higher fauna diversities.

Ornithological studies in Arizona and New Mexico have demonstrated the importance of riparian habitats to breeding birds. Of 112 species breeding along the Gila River, 49.1% were either exclusively or primarily found nesting in the riparian zone (Hubbard 1971). Another 22.3% of the species showed minor to high utilization of riparian zones. Similar levels of species have been reported for the San Juan River (Schmitt 1976) and along the Verde River (Carothers and Johnson 1973). During the brief survey along Nogales Wash (Croschupf 1986), the cottonwood-willow type had a higher avian diversity than the less complex habitats surveyed. Riparian habitats are also important for the continued maintenance of mammal and amphibian populations.

The importance of riparian habitat in Arizona is further evidenced in the efforts of the AGFD, Bureau of Land Management, Bureau of Reclamation, Forest Service, SCS and Service to restore and enhance riparian habitat on lands under their management or planning authority. The Bureau of Reclamation has funded numerous studies on both the importance and restoration of riparian habitat along the Colorado River. The Arizona Riparian Council was formed in 1985 to address issues concerning this important resource. Because of the importance of riparian habitat in the project area, losses should be prevented or minimized wherever practicable.

In-kind mitigation for the proposed project could be accomplished in several ways. Preservation of existing riparian habitat within the Nogales Wash drainage area would provide adequate mitigation for project losses. Mitigation could be accomplished in the first year because most of the habitat values needed may currently be present on the parcel. Possible areas of acquisition include Potrero Creek above and below the CVPIC, and the gallery forest downstream of the CWNWC.

Improvement of existing riparian areas and the establishment of new riparian areas requires a longer time frame to accomplish full mitigation since it may take many years to develop the complexity of the vegetative structure needed. Nonetheless, improvement, establishment and maintenance of riparian habitat would provide adequate mitigation provided the time delay to attain high habitat value is taken into account.

Table 1. Losses of riparian vegetation from the proposed CVC feature of the Nogales Wash Flood Control Project.

Cottonwood-willow	4.39 acres
Mixed Riparian	1.38 acres
Msquile	.21 acres
Total	5.99 acres

The Corps has finalized a HEP report which was used to develop a mitigation plan that utilizes the principles described above. The Corps plan contains two components. The first would involve acquisition of 5.5 acres of riparian habitat along the Potrero Creek Low Flow Channel downstream of the project. The quality of existing riparian habitat would be improved by pole plantings of cottonwood and willow trees and the fencing to exclude cattle. The second would involve acquisition of the 2.65-acre, vegetated depression immediately north of the Chula Vista subdivision adjacent to the west bank of the CVNCC. This area would also be fenced.

In addition to these two mitigation areas, the Corps proposed project contains a provision to revegetate 2.51 acres along the CVC with cottonwood and willow pole plantings for aesthetic purposes. This acreage would not be considered mitigation since revegetation for aesthetics would have been required along these structures in any case.

Details of the HEP evaluation performed by the Corps is available in their Draft Environmental Assessment and are not included in this report.

A plan detailing planting areas, methods, species and long term maintenance requirements should be developed in coordination with ACFD, and the Service. This plan should be approved by the Corps and Santa Cruz County to ensure that proper maintenance of the mitigation areas and CVC aesthetic treatment area is provided. These areas are to be managed for wildlife habitat and riparian values and any maintenance should protect those values.

We also believe that a 5-year monitoring program on improvement and establishment areas is needed. Even though both the Potrero Creek and CVC planting areas would have adequate water to sustain plantings, improper implementation of the planting scheme could result in losses of poles, cuttings and seedlings leaving the areas without the necessary vegetative component to develop the habitat value assumed in the HEP analysis. Full mitigation would then not be accomplished. Provision to re-plant areas where plantings fail (i.e. survival less than 80%) is crucial to the success of the entire plan. Provisions for monitoring and re-planting could be contained in the management plan discussed previously.

RECOMMENDATIONS

To provide equal consideration for fish and wildlife resources, we recommend that the following mitigation measures be implemented for the Nogales Wash Flood Control Project:

1. We recommend that either the mitigation plan identified by the Corps or in their 1987 draft Feasibility Report and Environmental Assessment or a plan that would acquire 5.94 acres of mature existing riparian vegetation be implemented by the Corps. The Corps plan provides for

the acquisition of 5.5 acres along Potrero Creek and 2.65 acres along Nogales Wash.

2. A management plan for any mitigation area should be developed and approved by the Corps, Santa Cruz County, ACFD and Service. This plan should include the following information:
 - A detailed planting design that includes species, planting times and methods and protection to be afforded seedlings and poles.
 - A 5-year monitoring plan of the plantings to document survival of plantings.
 - Provisions to replant areas with a less than 80% survival rate.
 - Guidelines on maintenance of the mitigation area to include any pruning, thinning or other physical manipulation of the vegetation.
 - Guidance on appropriate recreation to be permitted in the areas.

The Service appreciates the opportunity to provide you with this report on the fish and wildlife resources that would be affected by the Nogales Wash Flood Control Project. If we may be of further assistance, please contact Ms. Lesley Fitzpatrick or me (Telephone: 602/261-4720 or FIS 261-4720).

Sincerely,

Shawn M. Bauman
 Shawn M. Bauman ACTING FIELD SUPERVISOR
 Sam F. Spiller
 for Field Supervisor

Enclosures

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Appendix 1. Common and scientific names of all bird species observed in Nogales Wash, May-July 1986. Species only observed adjacent to or flying over the area are marked with an asterisk. (Groschupf 1986).

Common Name	Scientific Name
*Great Blue Heron	<u>Ardea herodias</u>
Black-bellied Whistling Duck	<u>Dendrocygna autumnalis</u>
Turkey Vulture	<u>Cathartes aura</u>
Gray Hawk	<u>Buteo nitidus</u>
*American Kestrel	<u>Falco sparverius</u>
*Gambel's Quail	<u>Callipepla gambelli</u>
*Killdeer	<u>Charadrius vociferus</u>
*Rock Dove	<u>Columba livia</u>
White-winged Dove	<u>Zenaida asiatica</u>
Mourning Dove	<u>Zenaida macroura</u>
*Common Ground-Dove	<u>Columbina passerina</u>
Yellow-billed Cuckoo	<u>Coccyzus americanus</u>
Broad-billed Hummingbird	<u>Cynanthus latirostris</u>
Black-chinned Hummingbird	<u>Archilochus alexandri</u>
Broad-tailed Hummingbird	<u>Selasphorus platycercus</u>
Rufous/Allen's Hummingbird	<u>Selasphorus sp.</u>
Gila Woodpecker	<u>Melanerpes uropygialis</u>
*Ladder-backed Woodpecker	<u>Picoides scalaris</u>
Northern Flicker	<u>Colaptes auratus</u>
Northern Beardless-	
Tryannulet	<u>Camptostoma imberbe</u>

Western Wood-Pewee	<u>Contopus sordidulus</u>	Summer Tanager	<u>Piranga rubra</u>
Black Phoebe	<u>Sayornis nigricans</u>	Western Tanager	<u>Piranga ludoviciana</u>
Vermilion Flycatcher	<u>Pyrocephalus rubinus</u>	Northern Cardinal	<u>Cardinalis cardinalis</u>
Ash-throated Flycatcher	<u>Myiarchus cinerascens</u>	Black-headed Grosbeak	<u>Phaeocephalus melanocephalus</u>
Brown-crested Flycatcher	<u>Myiarchus tyrannulus</u>	Blue Grosbeak	<u>Coccyzus caerulea</u>
Cassin's Kingbird	<u>Tyrannus vociferans</u>	Brown Towhee	<u>Pipilo fuscus</u>
•Western Kingbird	<u>Tyrannus verticalis</u>	Albert's Towhee	<u>Pipilo aberti</u>
•Northern Rough-winged		•Rufous-crowned Sparrow	<u>Amphispiza bilineata</u>
Swallow	<u>Stelgidopteryx serripennis</u>	•Black-throated Sparrow	<u>Amphispiza bilineata</u>
•Cliff Swallow	<u>Hirundo pyrrhonota</u>	Song Sparrow	<u>Melospiza melodia</u>
•Barn Swallow	<u>Hirundo rustica</u>	Red-winged Blackbird	<u>Agelaius phoeniceus</u>
•Chihuahuan Raven	<u>Corvus cryptoleucus</u>	Brewer's Blackbird	<u>Euphagus cyanocephalus</u>
Verdin	<u>Auriparus flaviceps</u>	Great-tailed Grackle	<u>Quiscalus mexicanus</u>
Bewick's Wren	<u>Thryomanes bewickii</u>	Bronzed Cowbird	<u>Molothrus aeneus</u>
Hermit Thrush	<u>Catharus guttatus</u>	Brown-headed Cowbird	<u>Molothrus ater</u>
Northern Mockingbird	<u>Mimus polyglottos</u>	Hooded Oriole	<u>Icterus cucullatus</u>
•Curve-billed Thrasher	<u>Toxostoma curvirostre</u>	Northern Oriole	<u>Icterus galbula</u>
•Cedar Waxwing	<u>Bombycilla cedrorum</u>	House Finch	<u>Carpodacus mexicanus</u>
Phainopepla	<u>Phainopepla nitens</u>	Lesser Goldfinch	<u>Carduelis psaltria</u>
European Starling	<u>Sturnus vulgaris</u>	House Sparrow	<u>Passer domesticus</u>
Bell's Vireo	<u>Vireo bellii</u>		
Warbling Vireo	<u>Vireo gilvus</u>		
Orange-crowned Warbler	<u>Vermivora celata</u>		
Lucy's Warbler	<u>Vermivora luciae</u>		
Yellow Warbler	<u>Dendroica petechia</u>		
Common Yellowthroat	<u>Geothlypis trichas</u>		
Wilson's Warbler	<u>Wilsonia pusilla</u>		
Yellow-breasted Chat	<u>Icteria virens</u>		

Appendix 2. Wildlife species that may be found in the Nogales Wash Project area.

<u>COMMON NAME</u>	<u>SCIENTIFIC NAME</u>
Couch's spadefoot toad	<u>Scaphiopus couchi</u>
Western whiptail lizard	<u>Chemidophorus tigris</u>
Tree lizard	<u>Urosaurus ornatus</u>
Side-blotched lizard	<u>Uta stansburiana</u>
Sonoran mud turtle	<u>Kinosternon sonoriense</u>
Cotton rat	<u>Sigmodon hispidus</u>
Cartus mouse	<u>Peromyscus eremicus</u>
Desert pocket mouse	<u>Perognathus penicillatus</u>
Round-tailed ground squirrel	<u>Spermophilus tereticaudus</u>
Pinnet gopher	<u>Inomys bottae</u>
Wood rat	<u>Neotoma albigula</u>
Striped skunk	<u>Mephitis mephitis</u>
Hooded skunk	<u>Mephitis macroura</u>
Coatimundi	<u>Nasua nasua</u>
Raccoon	<u>Procyon lotor</u>
Coyote	<u>Canis latrans</u>

Appendix 3. Special Status Species Reported from the Nogales Wash Area

<u>SCIENTIFIC NAME</u>	<u>CATEGORY</u>
<u>Beardless Cinch Weed (Pectis imberbis)</u>	Category 2 candidate (federal)
<u>Mexican Garter Snake (Thamnophis eques)</u>	Group 3 (state)
<u>Desert Hooknosed Snake (Cyalopton quadrangulatis)</u>	Group 3 (state)
<u>Grey hawk (Buteo nitidus)</u>	Group 2 (state)
<u>Northern Beardless Tyrannulet</u>	
<u>(Campostoma imberbe ridgwayi)</u>	Group 3 (state)
<u>Black-bellied Whistling Duck</u>	
<u>(Dendrocygna autumnalis fulgens)</u>	Group 4 (state)
<u>Mountain Skink (Eumeces calliscephalus)</u>	Group 4 (state)
<u>Plains Narrow-mouthed Toad</u>	
<u>(Gastrophryne olivacea)</u>	Group 4 (state)
<u>Yaqui Black-headed Snake</u>	
<u>(Tantilla yaquila)</u>	(No official status)
<u>Western Yellow-billed Cuckoo</u>	
<u>(Coccyzus americanus occidentalis)</u>	Category 2 candidate (federal)
<u>Thick-billed Kingbird</u>	
<u>(Tyrannus crassirostris)</u>	Group 3 (state)
<u>Rose-throated Becard (Pachyrhamphus agalae richmondi)</u>	Group 3 (state)

APPENDIX C

HEP ANALYSIS AND INCREMENTAL JUSTIFICATION OF MITIGATION

NOGALES WASH FEASIBILITY STUDY
HABITAT EVALUATION PROCEDURE AND
INCREMENTAL JUSTIFICATION OF MITIGATION REPORT

I. Introduction

This report provides detailed back-up information used in the preparation of the Environmental Assessment for the Nogales Wash feasibility study. The information presented here outlines the goals, objectives, assumptions, and results of the Habitat Evaluation Procedure (HEP) study and mitigation plan associated with the Nogales Wash Feasibility study. Federal regulations encourage the use of habitat based evaluation procedures when analyzing the impacts of projects on ecological resources. Corps regulations require an incremental justification of mitigation plans. HEP studies lend themselves very well to use in incremental justifications of mitigation plans. Thus, the information presented here discusses in detail how these regulatory requirements were fulfilled.

The mitigation goals included the desire to mitigate fully (100% mitigation) for the project-related impacts to ecological resources. The goal was set at this level due to the great importance of riparian habitats in the arid southwest. This habitat type is extremely important to wildlife species in the desert. The abundance of resources, especially water, cover, and food, are very important to most desert species (not only obligate riparian species). In addition, much of this highly productive habitat has been lost in the arid southwest over the years due to changing land use (e.g. grazing, urbanization with increased erosion rates), flood control activities (channel clearing, channelization, and dam construction), and wood cutting for fuel. Thus, the importance of, and past cumulative losses to this habitat was considered in choosing a 100% mitigation goal.

The Habitat Evaluation Procedure, developed by the U.S. Fish and Wildlife Service, is a very useful habitat-based evaluation technique. It provides a way to quantify and account for gains and/or losses in habitat value resulting from some action. Typically, species requirements are modelled wherein the parameters used are some set of habitat variables that have been deemed by species experts as important in determining the suitability of any habitat to that species. The models (referred to as Habitat Suitability Models) are used to calculate a Habitat Suitability Index (HSI) value which indicates how suitable the habitat in question is for the species modelled.

The model used in this study was developed by the U.S. Fish and Wildlife Service Habitat Evaluation Procedures Group in Fort Collins, Colorado. It is titled the Arizona Layers of Habitat Model and is presented in the U. S. Fish and Wildlife Service publication (# FWS/OBS-82/10.70) entitled "Habitat Suitability

Index Models: The Arizona Guild and Layers of Habitat Models" (The Model). This model differs from most HSI models in that it does not model a single species, but rather models the habitat for an entire assemblage of species by relating the structure of that habitat to the wildlife guilds of the ecoregion. The model is similar to most in that it is used to calculate a HSI value between 0.0 and 1.0. A value of 1.0 indicates prime habitat or habitat that is the best of its type in the ecoregion. More details of the model are presented in the sections that follow.

II. Study Methodology

A. Study Objectives

The objectives of the HEP were as follows:

- (1) To determine the type and value of existing and future resources to be affected by the project.
- (2) To quantify clearly the impact to biological resources from the proposed project (Alternative #1) and Alternative #2.
- (3) To determine mitigation needs and opportunities to compensate for project related impacts.

Data collection, analysis, and public resource agency coordination efforts were planned and implemented to accomplish these objectives.

B. Coordination with Resource Agencies

The HEP study was coordinated with two other public resource agencies. Those agencies and their contact persons are displayed in table 1.

Table 1 Resource Agency Contacts Involved in the HEP Analysis.

Agency	Contact
U.S. Army Corps of Engineers Los Angeles District Los Angeles, California	David Castanon
U.S. Fish and Wildlife Service Ecological Services, Field Office Phoenix, Arizona	Lesley Fitzpatrick
Arizona Department of Game and Fish Tucson, Arizona	Vashti "Tice" Supplee

C. Data Collection Methodology

Data collection centered on the riparian habitat resources of Nogales Wash and Potrero Creek in and near the vicinity of the proposed Chula Vista Channel (CVC).

The HEP team (Corps, USFWS, and ADGF) collected the field data for the HEP study together in April 1986. Data collection consisted of two primary tasks. The first task was to field truth the preliminary vegetation maps generated by photo-interpretation of aerial photographs (scale: 1 inch = 200 ft.). The preliminary maps delineated 3 different cover types in and near the two streams. The urbanized areas and heavily grazed lots were ignored in this study as their value as wildlife habitat is extremely limited. Field truthing enabled refinement of the maps. Field truthing consisted of traveling to various points within the mapped area (which, at the time, included all of Nogales Wash between the International Border and Potrero Creek as well as Potrero Creek between the Hwy 89 crossing and the Santa Cruz River) and visually matching the vegetation map to whatever was observable from that point. Corrections were made on the preliminary vegetation maps when observable conditions did not match the maps. Following the field truthing, a final vegetation map was produced and utilized in the HEP study (Plate 3 of the EA).

The second task was to sample canopy coverage for separate layers of habitat in at least two representative stands of each of the 3 different cover types. The habitat layers sampled and their definition were:

Table 2 Habitat Layers Sampled in HEP Study.

Habitat Layer	Height Interval from Ground
Tree Canopy	Vegetation above 25 ft.
Tree Bole	Any height above ground.
Shrub Midstory	Vegetation between 20 inches and 25 feet.
Understory	Vegetation from the surface to 20 inches above it.
Terrestrial Subsurface	At the surface.
Surface Water Layer	At the surface.

The 3 cover types consisted of different assemblages of riparian species. The cover types were named and described as follows:

Table 3 Description of Cover Types.

Cover Type	Description
Cottonwood-Willow	Dominated by cottonwood (<u>Populus fremonti</u>) and willow (<u>Salix sp.</u>). All 6 habitat layers present.
Mixed Riparian	Usually a mixture of species, including Mexican elder (<u>Sambucus mexicana</u>), mesquite (<u>Prosopis sp.</u>), and willow. Occasional cottonwoods, though usually small. Occasionally dominated by Mexican elderberry. All habitat layers present except the tree canopy layer.
Mesquite Stands	Dominated by mesquite, occasionally in very dense mesquite bosque stands. Tree canopy and Tree Bole habitat layers absent.

The field data measuring coverage for each habitat layer for each cover type has been reduced and is presented in table 4. In the case of the cottonwood-willow cover type, 5 representative stands were sampled. Three and two stands were sampled of the mixed riparian and mesquite cover types, respectively. Early in the study, the HEP team had planned to evaluate several miles of stream (Potrero Creek, from the Santa Cruz River up to Nogales Wash and Nogales Wash, from Potrero Creek up to the existing open concrete channel). As such, the team decided to sample those cover types expected to be of higher value and which could potentially skew the modelling results. Also, since mitigation measures were expected to center on creating or improving cottonwood/willow habitats, the team wanted to have more data on the habitat structure of that type in order to have a better understanding of how the mitigation or habitat improvement plans should be designed.

Sampling of each stand consisted of line intersect measurements for a distance of 200 meters. The line intersect method of vegetation sampling consists of measuring the distance along a tape that a plant (or, in this case, the vegetation

layer) intersects with the vertical projection of the tape (i.e. the vertical plane above or below the tape. The 200-meter tapes were placed in the generally linear riparian habitats, roughly parallel to the stream channel. Sampled stands were not randomly selected. However, they were placed in representative stands of each cover type by mutual agreement of the HEP team.

Due to the natural windings of the stream channel, the tape would occasionally intersect with the stream. Thus, the measurement of terrestrial subsurface and aquatic surface habitat layers were visually estimated at 90% and 10%, respectively for all stands sampled. These two layers were not specifically measured along the tapes as the relative coverage of each had no affect on the HSI values generated by the Layers of Habitat Model.

Table 4 Reduced Field Data.

<u>Cover Type</u>	<u>Habitat Layer</u>	<u>Ave. Coverage</u>	<u># of Samples</u>
Cottonwood-willow	Tree Canopy	56.4%	5
	Tree Bole	Present	5
	Midstory	72.6%	5
	Understory	35.8%	5
	Terr. Subsurf	90%	5
	Aquatic Surface	10%	5
Mixed Ripar.	Tree Canopy	1.7%	3
	Tree Bole	Present	3
	Midstory	89.7%	3
	Understory	68.7%	3
	Terr. Subsurf	90%	3
	Aquatic Surface	10%	3
Mesquite	Tree Canopy	0.0%	2
	Tree Bole	Absent	2
	Midstory	93.5%	2
	Understory	45.0%	2
	Terr. Subsurf	90%	2
	Aquatic Surface	10%	2

This data was used to calculate Habitat Suitability Indices (HSI's) for each of the different cover types.

D. Habitat Evaluation and Impact Assessment

Evaluation of habitat values was accomplished through the use of the habitat suitability index model developed by Mr. Henry Short of the U.S. Fish and Wildlife Service Habitat Evaluation

Procedures Group in Fort Collins, Colorado (USFWS, 1984). This model is entitled, "The Arizona Guild and Layers of Habitat Models" and was published in 1984.

This model, hereafter referred to as the Layers of Habitat Model, is based on the significant association of wildlife species with vegetation structure. The model compares the vegetation structure in the study area with the vegetation structure that could potentially occur in the study area. The model assumes that the vertical dimension of the vegetation community is an important factor in the way that wildlife species (especially birds) partition the food and reproductive resources of habitats.

The model was specifically developed for habitats in the Sonoran Desert of west-central Arizona. As such, use of this model is particularly appropriate insofar as it was developed for use in the ecoregion in which the project resides. Further, the data requirements for this model are obtainable at relatively low cost - an important consideration for a cost-shared study.

The intent of the Layers of Habitat Model is to provide a way to measure the diversity in habitat structure in a study area. The HSI values are numerical representations of that structural diversity. Greater HSI values determined with the model are expected to represent greater habitat diversity which is expected to be accompanied by increased animal diversity.

Although the model makes no value judgments on the merits of wildlife species diversity, the HEP team agreed that because the affected cover types all consisted of various types of riparian habitat, more species/habitat diversity was better than less. That is, since no tradeoffs between significantly (qualitatively) different cover types were involved (e.g. marsh vs. grassland), more diverse riparian habitats were preferable to less diverse riparian habitats (e.g. mixed riparian could be traded off for cottonwood-willow habitat). This reasoning was used in the development of mitigation measures to compensate for losses of habitat values expected to result from the project.

This model assumes that vertebrate wildlife species partition habitat resources along a vertical dimension and that this vertical dimension can be represented as habitat layers. Habitat layers used in the model are defined in table 1 above. The criteria used to determine whether any layer is present is presented in table 5.

In determining HSI values, the Layers of Habitat Model considers cover types to be combinations of habitat layers as defined in tables 2 and 5. They consist of volumes of space at various levels above or below the air-terrestrial/aquatic surfaces. The symbolic statement of the HSI calculation using

Table 5 Criteria Used to Establish the Presence of Habitat Layers.

Habitat Layer	Presence/Absence Criteria
Tree Canopy	At least 5% cover when projected to the surface.
Tree Bole	Dbh greater than 8 inches.
Shrub Midstory	At least 5% cover when projected to the surface.
Understory	At least 5% cover when projected to the surface.
Terrestrial Subsurface/ Aquatic Surface Layer	Always present, but mutually exclusive.

this model is:

$$HSI = \frac{1 \sum_{i=1}^l A_i}{(6)(5) \sum_{j=1}^n A_j}$$

- where
- 1 = the number of layers of habitat present within some bounded area.
 - A_i = the area of habitat layer i within the bounded area.
 - A_j = the surface area of cover type j within the bounded area.
 - n = the number of different cover types present within the bounded area.
 - 6 = the maximum number of habitat layers present in a unit of structurally complex riparian treeland.
 - 5 = the maximum number of units of area of habitat layers that can occur within a unit of structurally complex riparian treeland.

The numerator is the number of layers of habitat actually present on an area multiplied by the total area of the individual layers of habitat actually present. The denominator is the product of the number of habitat layers potentially present in the most structurally complex cover type that could theoretically occur on the assessment area and the area of the layers of habitat that could exist in this structurally complex cover type.

Thus, an area of structurally complex riparian treeland habitat can contain six habitat layers (tree canopy, tree bole, midstory, understory, terrestrial subsurface, and aquatic surface). The tree canopy, tree bole, midstory, and understory layer can each extend throughout the riparian treeland area and, if the total surface area = 100 units, provide a total of 400 units of area of habitat layers. The terrestrial subsurface and aquatic surface layers can occur within a riparian treeland area but their combined area would only equal 100 units in this example, as the areas they occupy are mutually exclusive (i.e. It is impossible to have both in the same place simultaneously). Thus, the denominator of the proportion equals 6 habitat layers that could occur on the assessment area times 500 units of habitat layers. Therefore, the equation for the denominator would be as follows:

$$(6)(5)(100) = (30)(100)$$

The value 30 x evaluation area is a standard denominator for the HSI calculation using the layers of habitat model.

The HSI model above was used to calculate HSI values for each of the four cover types. Those HSI values are displayed in table 6.

Table 6 Cover type HSI values.

<u>Cover Type</u>	<u>HSI</u>	<u>Number of Habitat Layers</u>
Cottonwood/willow	1.0	6
Mixed Riparian	0.67	5
Mesquite	0.40	4
Planted Areas*	0.21	3

* = Planted mitigation and ROW lands initially have only 3 habitat layers, but in all cases are designed to develop into cottonwood-willow forest over time. The HSI value of 0.21 was derived by assuming that only 3 habitat layers are

present immediately after planting of the ROW or bare mitigation areas to undergo habitat improvement.

Habitat values were calculated in terms of Habitat Units (HU). One HU is defined as 1 acre of prime habitat (i.e. habitat with an HSI of 1.0). Thus HU's are calculated by multiplying an area's HSI value by the size of the area in acres. In the following sections of this appendix, environmental conditions at various points in time (with and without the project) are presented as Habitat Units. Habitat Units are presented for each cover type and in summary form (by summing the HU's for each cover type) for each environmental condition analyzed.

III. Environmental Setting

A. Nogales Wash and Potrero Creek

Plate 3 of the EA displays the current extent of vegetation along Nogales Wash and Potrero Creek in the vicinity of the Chula Vista Channel (CVC). Outside of the grazed lots north and south of the Chula Vista community and the residential community itself, there are 3 different cover types shown: Cottonwood/willow; Mixed Riparian; and Mesquite Stands.

A digital planimeter was used to determine the aerial extent of each cover type. That data is displayed below in table 6.

Table 6 Existing Condition Habitat Unit Calculations.

<u>Cover Type</u>	<u>HSI</u>	<u>Acreage</u>	<u>Habitat Unit</u>
Cottonwood/ willow	1.0	8.48	8.48
Mixed Riparian	0.67	13.38	8.96
Mesquite	0.40	5.32	2.13

Tables similar to table 6 above were constructed for the following situations:

1. Existing conditions (target year 0, see table 6 above).
2. Conditions at target year 1 without project (assumed to be equal to existing conditions).

3. Conditions in the future without project (target year 100).
4. Conditions immediately after construction, no mitigation (target year 1).
5. Future conditions after construction, no mitigation (target year 100).
6. Conditions immediately after construction, with mitigation (target year 1).
7. Future conditions after construction, (with mitigation (target year 100)).

Tables displaying conditions 4 through 7 were compiled for both Alternative #1 (the proposed project) and Alternative #2. These tables are attached to this Appendix and listed as Form B Tables. Form B tables are generated by the U.S. Fish and Wildlife Service HEP Computer program for IBM Personal Computers. Form B tables are of the same basic form as table 6 above.

IV. Impact Assessment

Impacts to habitat resources were quantified by calculating the net change in average annualized HU's (AAHU) between any two set of conditions. For example, the quantified impact of the proposed project (assuming no mitigation measures are employed) would be the net change in AAHU's between number of AAHU's (over the 100 year time frame) for the without-project condition and the number of AAHU's (over the 100 year time frame) resulting from implementation of the project without mitigation.

The HEP computer program produces Form C which displays the AAHU's calculated for each condition. The Form C tables are also attached to this appendix for reference.

A. No Project Condition

The calculation of the AAHU's represented by the No Action Alternative requires that one predict the future aerial extent of each of the three cover types. Of primary importance to this prediction is the expected amount of future bank erosion along Nogales Wash. Studies by the Corps of several historical aerial photographs of Nogales Wash revealed that past erosion rates have been significant. It was assumed by the Corps for both this HEP analysis and other (e.g. economic) studies associated with this project that the past erosion rates, measured from the set of historical photographs, would continue into the future. As such, Plate 1, of the EA, displays the future (100 year) extent of bank

erosion expected along Nogales Wash. The HEP computer program tables (Form C tables) indicate that the No Action Alternative would result in AAHU figures of:

Cottonwood-willow AAHU's	= 5.92
Mixed Riparian AAHU's	= 6.40
Mesquite Stand AAHU's	= 2.13
Newly Planted Areas AAHU's	= 0.00
<hr/>	
Total (sum) AAHU's	= 14.45

B. With-Project Conditions

Future with-project conditions were evaluated by first overlaying the proposed project alignment and attendant right of ways over the vegetation depicting existing conditions. The digital planimeter was then used to determine the remaining acreage of each cover type for target year 1 (immediately after construction) and for target year 100 (100 years after construction). These figures are displayed in the Form B tables (attached). The data in the Form B tables was then used by the HEP computer program to determine the number of AAHU's associated with each project condition (see the attached Form C tables). The information in the Form C tables are condensed in table 7 below.

Table 7 AAHU's Associated With Each of the Project Conditions Analyzed.

Project Condition	Total AAHU's
Proposed Proj., no mitigation	10.66
Proposed Proj., w/ full mitigation	14.45
Alt. #2, no mitigation	11.51
Alt. #2, w/ full mitigation	14.48

In predicting the acreage of various cover types for target year 100 when mitigation measures were included, the following assumptions were made.

1. All mitigation sites that had no vegetation immediately following construction would be designed to develop

into cottonwood/willow riparian forest during the 100 year time frame of analysis.

2. All mitigation sites that did have riparian habitat immediately following construction, but without the cottonwood/willow cover type, would undergo habitat improvement to enable the sites to develop into cottonwood/willow riparian forest during the time frame of analysis.
3. The mitigation sites that did have cottonwood-willow riparian forest immediately following construction would be preserved as is without any habitat improvement measures except for fencing from grazing animals.
4. Aesthetic treatment (revegetation) of the Right of Way (ROW) is a normal part of Corps channelization projects and was assumed to be part of the proposed project. However, proper design of the Aesthetic treatment to include species typical of a cottonwood/willow riparian forest would reduce the amount of mitigation ultimately required. Thus, the aesthetic treatment of the ROW would be taken into account in the HEP analysis as part of the proposed project and not as part of the mitigation plan.

C. Impacts and Mitigation

The computer program also produced Form D tables which display the net change in AAHU's between any with-project condition and the without-project condition. Form D tables are attached to this appendix and summarized in table 8 below.

Table 8 Net Change in AAHU's Between the No Action Plan and the Following Conditions.

Condition Compared Against the No Action Alternative	Net Change in AAHU's
Proposed project, without mitigation	$10.66 - 14.45 = -3.79$
Proposed project, with mitigation	$14.45 - 14.45 = 0.00$
Alternative #2, without mitigation	$11.51 - 14.45 = -2.94$
Alternative #2, with	$14.48 - 14.45 = +0.03$

mitigation

As can be seen from table 8, Alternative #1 (the proposed project) and Alternative #2 each sustained losses of habitat value (as measured in AAHU's) in those conditions without mitigation. However, when mitigation measures were included, the goal of no net loss in habitat values was attained. The mitigation plan formulated for the recommended plan resulted in a net change in AAHU's of 0.00. Thus, all impacts to habitat values were fully (though not over) compensated by the mitigation plan. The mitigation plan formulated for Alternative #2 resulted in a slight over mitigation (i.e. net change in AAHU's of +0.03). However, if Alternative #2 is chosen over Alternative #1 (the current recommended plan, the mitigation plan for Alternative #2 can be fine tuned to eliminate any over mitigation.

The extremely low numbers generated for net change in AAHU's are the result of an iterative process whereby the amount of land needed for mitigation purposes was arrived at by a series of increasingly refined estimates.

V. Incremental Justification of Mitigation

The incremental justification of mitigation analysis required that mitigation costs be annualized. Thus, as in the main report, the following convention was used:

A. Annual interest rate of 8 and 7/8 percent over 100 years translates into an amortization rate of .08875. This amortization rate, when multiplied by the initial mitigation cost, enables the calculation of the average annual cost of mitigation. Of course, this assumes (and the mitigation plan has been designed around the assumption) that no operation or maintenance costs are necessary.

The following assumptions were also made:

A. Cost of lands for mitigation is estimated to be \$1,000 per acre. This is below most of the area's land cost. However, lands to be acquired for mitigation may also be subject to Corps 404 permit jurisdiction. Thus, as wetland areas prone to flooding, development might be more difficult to achieve and the land value is reduced.

B. Habitat improvement measures have been estimated to be \$10,000 per acre. This includes plantings of dormant cottonwood poles, willow cuttings, seeding with a variety of riparian species, and fencing.

C. Fencing of the small depression area was estimated to be approximately \$5,300 for that 2.7 acre parcel. This

fence will have an access point to connect with the recreation bike trail along the CVC.

D. Implementation of the aesthetic treatment plan is included in the base condition as part of the proposed project. Should the aesthetic treatment plan be removed from the proposed project, the 1.13 AAHU's that it provides would need to be provided by other additional mitigation measures in order to attain the goal of full mitigation of impacts.

The optional mitigation measures, their costs, and the average annualized number of habitat units they provide (as calculated in the HEP analysis) are presented below and in figure HEP-1.

Mitigation Option A consists of the Depression Area. This parcel could also be considered project-affected land in that it will be removed from flooding and thus rendered developable. However, the depression is less desirable as developable land than is the rest of the grazed pasture since it would need to be filled. In addition, it is possible that the site could be considered a wetland and thus fall under the purview of Corps 404 permit jurisdiction. In any event, its currently vegetated state provides substantial habitat value to the overall mitigation plan without the expenditure of habitat improvement funds and without having to wait for the vegetation to develop. Each AAHU provided by this component of the mitigation plan costs \$690 annually. This site is adjacent to the project area.

Mitigation Option B consists of the Potrero Creek areas which are considered project-affected lands insofar as the project will redirect natural low and flood flows to the south of the Chula Vista subdivision. The monetary efficiency of this portion of the mitigation plan can be represented by dividing the AAHU's that this component provides by the annual cost of this component of the mitigation plan. The 5.5 acres along Potrero Creek and the habitat improvements will provide 2.78 AAHU's at an annual cost of \$4,900. Therefore, each AAHU costs \$1,760 annually. This site is adjacent to the project area.

Various other optional mitigation plan components were evaluated early in the HEP analysis, but were determined to be much more costly than the two chosen options. One (Option C) entailed the purchase and habitat improvement of the 2.2 acre parcel of land located just north of the levee (along the diversion channel portion of the CVC) and just south of the Chula Vista community. This parcel is currently part of a heavily grazed pasture and would be removed from the flood plain by the proposed project. Habitat improvement features would necessitate the installation of a permanent irrigation system as well as intensive plantings to attain the goal of development of a Cottonwood-willow riparian forest. This component would provide

only 1.22 AAHU's. Estimated costs of this component include \$10,000 per acre, or a total land cost of \$22,000. In addition, habitat improvement costs (including installation of a permanent sprinkler irrigation system) is estimated to cost \$50,000 per acre, for a total habitat improvement cost of \$110,000. Therefore, this component would have a total cost of \$132,000. This component would cost \$13,700 per year (including \$2,000 per year for O & M of the irrigation system). Each AAHU provided by this option costs \$11,200 per year.

Other optional mitigation plan components not chosen include mitigation along Nogales Wash either upstream or downstream of the CVC project area. These options were not chosen as they would be inconsistent with Corps policy prioritizing mitigation on project or project-affected lands. Further, these components are inherently inefficient. Mitigating on up and downstream portions of Nogales Wash would require large areas to obtain the required HU's. The habitat value of much of the existing vegetation in these areas could not be counted towards the mitigation plan as those values would exist with or without the project and are expected to continue to exist in the future as well. Thus, any mitigation credits derived in these areas would have to result from additional habitat improvements. However, improving habitat values further would be difficult since the riparian systems found along Nogales Wash have already developed in response to local conditions of topography, substrate, and hydrology. Further habitat improvements would require either substantial earth moving, or addition of new water supplies, or both. These tasks would be extremely expensive. Mitigation along Nogales Wash downstream of the project area would be very inefficient as these portions of Nogales Wash are expected to suffer significant bank erosion in the future. Thus, any habitat improvements would likely be lost with the eroded banks.

VI. Conclusion

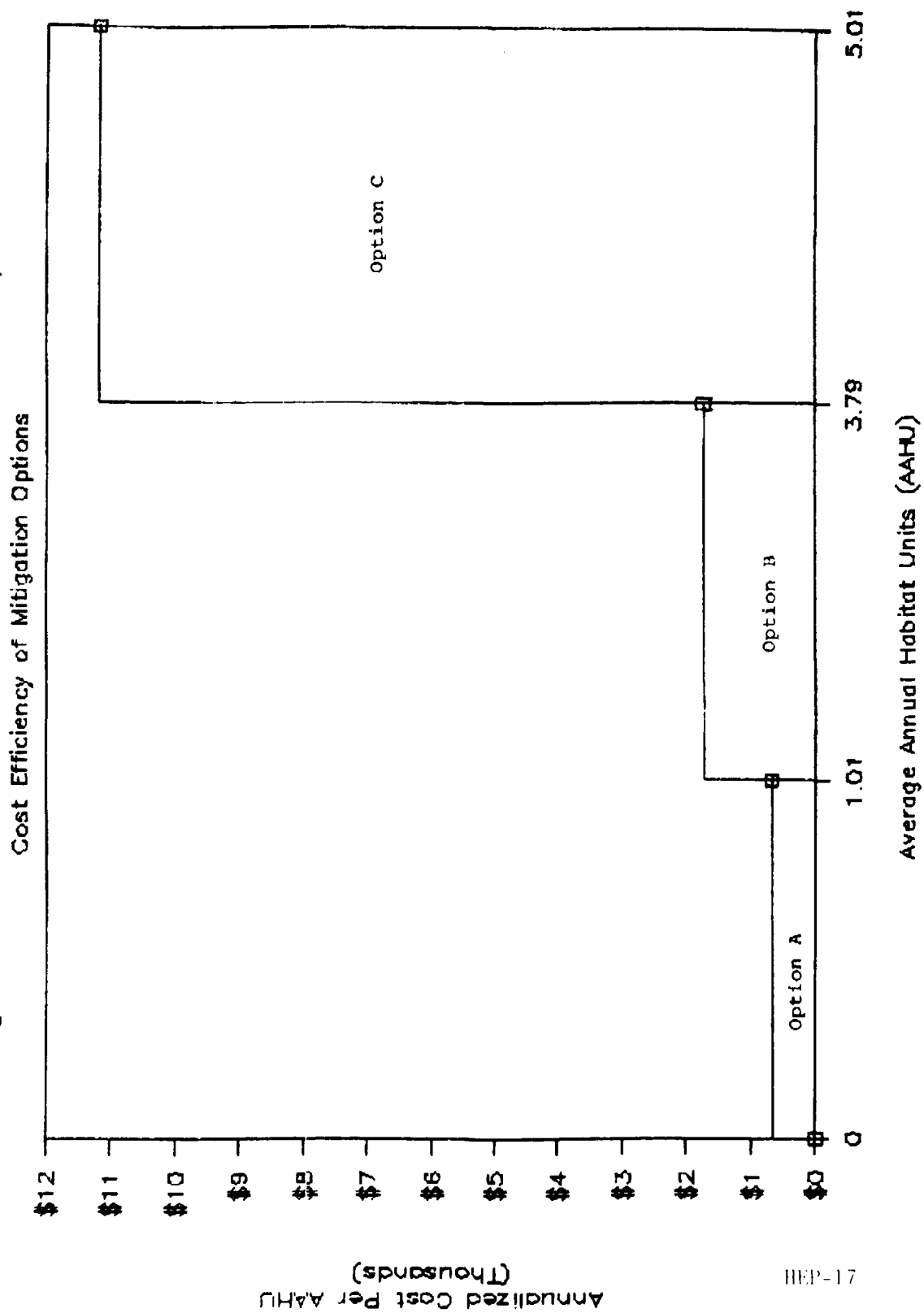
The HEP analysis conducted as part of the Environmental Assessment for the Nogales Wash Flood Control Project was coordinated with both Federal and State biological resource agencies. The model chosen for the HEP (developed by the USFWS) was especially appropriate for use in the Nogales Wash project as it was originally developed for use in the same ecoregion. The HEP was helpful in accounting project impacts to biological resources and in developing mitigation plans to meet the mitigation goal of full mitigation for project impacts. The goal of full mitigation was warranted due to: (1) the extreme high value of riparian habitat to desert wildlife species; and (2) the large proportion of southern Arizona's historical riparian habitat which has been lost due to groundwater pumping, changing land use, and water resource projects. The development of a recommended mitigation plan to meet the goal of full mitigation was done in a manner consistent with Corps mitigation policy

(Draft EC 1105-2-XXX, Fish and Wildlife Mitigation Planning: Incremental (Marginal) Cost Analysis, 22 May 1987).

The mitigation plan provides the 3.79 AAHU's needed to fully mitigate the project impacts at a total annualized cost of \$5,600, or \$1,480 annually per AAHU. The total initial cost of the mitigation plan for Alternative #1 is estimated to be \$62,700. This amount represents only about 1% of the initial project cost of nearly \$6,000,000.

The two components of the mitigation plan for the recommended project are ranked by preference. The preference ranking was established by use of Corps Engineering Regulation ER 1105-2-50, 1 August 84 in paragraph 2.4.d. (1) which states "...Mitigation of unavoidable losses shall be provided to the maximum extent practicable and justified through the development and improvement of lands required for other purposes." As such, design of the aesthetically treated CVC right of way to develop into cottonwood-willow riparian forest maximized use of required project lands. The habitat values provided by the aesthetic treatment plan is not considered a component of the mitigation plan to be justified incrementally. Aesthetic treatment would be implemented regardless of the need for mitigation. Thus the habitat values accruing from the aesthetic treatment plan is considered as part of the base condition of the project. In addition to the ROW lands, project-affected lands were evaluated for their usefulness as mitigation lands. Non-project land and non-project-affected land was considered to be a last choice for mitigation land as its use would conflict with Corps policy and the expected cost of habitat improvements were expected to be relatively high. The two components of the mitigation plan are also the most cost effective in terms of Habitat Units gained per dollar spent.

Figure HEP-1: Incremental Analysis



FORM B TABLES

CALCULATIONS OF HABITAT UNITS FOR
DIFFERENT PROJECT CONDITIONS AND AT VARIOUS TARGET YEARS

Without-Project Condition (Alt. #4)
Target Year 0

Cover Type	Area	HSI	HU
Cottonwood-Willow	8.48	1.00	8.48
Mixed Riparian	13.38	0.67	8.96
Mesquite Stands	5.32	0.40	2.13
Planted Areas	0.00	0.21	0.00
Total HU's =			19.57

Without-Project Condition (Alt. #4)
Target Year 1

Cover Type	Area	HSI	HU
Cottonwood-Willow	8.48	1.00	8.48
Mixed Riparian	13.38	0.67	8.96
Mesquite Stands	5.32	0.40	2.13
Planted Areas	0.00	0.21	0.00
Total HU's =			19.57

Without-Project Condition (Alt. #4)
Target Year 100

Cover Type	Area	HSI	HU
Cottonwood-Willow	3.30	1.00	3.30
Mixed Riparian	5.64	0.67	3.78
Mesquite Stands	5.32	0.40	2.13
Planted Areas	0.00	0.21	0.00
Total HU's =			9.21

With Project Condition (Alt. #1)
No Mitigation Plan
Target Year 1

Cover Type	Area	HSI	HU
Cottonwood-Willow	4.09	1.00	4.09
Mixed Riparian	12.00	0.67	8.04
Mesquite Stands	5.11	0.40	2.04
Planted Areas	2.51	0.21	0.53
Total HU's =			14.70

With Project Condition (Alt #1), No Mitigation
Target Year 100

Cover Type	Area	HSI	HU
Cottonwood-Willow	2.00	1.00	2.00
Mixed Riparian	2.90	0.67	1.94
Mesquite Stands	6.35	0.40	2.54
Planted Areas	0.00	0.21	0.00
Total HU's =			6.48

With Project Condition (Alt. #1)
Potrero Creek Component of Mitigation Plan Only
Target Year 1

Cover Type	Area	HSI	HU
Cottonwood-Willow	4.09	1.00	4.09
Mixed Riparian	12.00	0.67	8.04
Mesquite Stands	5.11	0.40	2.04
Planted Areas	4.67	0.21	0.98
Total HU's =			15.15

With Project Condition (Alt. #1)
Potrero Creek Component of Mitigation Plan Only
Target Year 100

Cover Type	Area	HSI	HU
Cottonwood-Willow	7.02	1.00	7.02
Mixed Riparian	3.11	0.67	2.08
Mesquite Stands	6.35	0.40	2.54
Planted Areas	0.00	0.21	0.00
Total HU's =			11.64

With Project Condition (Alt. #1)
Potrero Creek and Depression Area Mitigation Components
Target Year 1

Cover Type	Area	HSI	HU
Cottonwood-Willow	4.09	1.00	4.09
Mixed Riparian	12.00	0.67	8.04
Mesquite Stands	5.11	0.40	2.04
Planted Areas	4.68	0.21	0.98
Total HU's =			15.16

With Project Condition (Alt. #1)
Potrero Creek and Depression Area Mitigation Components
Target Year 100

Cover Type	Area	HSI	HU
Cottonwood-Willow	8.26	1.00	8.26
Mixed Riparian	4.31	0.67	2.89
Mesquite Stands	6.35	0.40	2.54
Planted Areas	0.00	0.21	0.00
Total HU's =			13.69

With Project Condition (Alt #2), No Mitigation
Target Year 1

Cover Type	Area	HSI	HU
Cottonwood-Willow	4.64	1.00	4.64
Mixed Riparian	12.46	0.67	8.35
Mesquite Stands	5.21	0.40	2.08
Planted Areas	2.34	0.21	0.49
Total HU's =			15.56

With Project Condition (Alt #2), No Mitigation
Target Year 100

Cover Type	Area	HSI	HU
Cottonwood-Willow	3.30	1.00	3.30
Mixed Riparian	2.94	0.67	1.97
Mesquite Stands	5.21	0.40	2.08
Planted Areas	0.00	0.21	0.00
Total HU's =			7.35

With Project Condition (Alt #2), Potrero Crk Mitigation Area
Target Year 1

Cover Type	Area	HSI	HU
Cottonwood-Willow	4.64	1.00	4.64
Mixed Riparian	12.46	0.67	8.35
Mesquite Stands	5.21	0.40	2.08
Planted Areas	4.74	0.21	1.00
Total HU's =			16.07

With Project Condition (Alt. #2)
 Potrero Creek Mitigation Area
 Target Year 100

Cover Type	Area	HSI	HU
Cottonwood-Willow	8.64	1.00	8.64
Mixed Riparian	3.15	0.67	2.11
Mesquite Stands	5.21	0.40	2.08
Planted Areas	0.00	0.21	0.00
Total HU's =			12.83

FORM C TABLES

CALCULATIONS OF AVERAGE ANNUAL HABITAT UNITS
FOR DIFFERENT PROJECT CONDITIONS

Without Project Condition (Alt. #4)

Cover Type	AAHU
Cottonwood-Willow	5.92
Mixed Riparian	6.40
Mesquite Stands	2.13
Planted Areas	0.00
Total =	14.45

With Project Condition (Alt. #1)
No Mitigation

Cover Type	AAHU
Cottonwood-Willow	3.08
Mixed Riparian	5.03
Mesquite Stands	2.29
Planted Areas	0.26
Total =	10.66

With Project Condition (Alt. #1)
Potrero Creek Mitigation Component Only

Cover Type	AAHU
Cottonwood-Willow	5.56
Mixed Riparian	5.10
Mesquite Stands	2.29
Planted Areas	0.49
Total =	13.44

With Project Condition (Alt. #1)
Potrero Creek and Depression Area Mitigation

Cover Type	AAHU
Cottonwood-Willow	6.18
Mixed Riparian	5.49
Mesquite Stands	2.29
Planted Areas	0.49
Total =	14.45

With Project Condition (Alt. #2)
No Mitigation

Cover Type	AAHU
Cottonwood-Willow	4.00
Mixed Riparian	5.19
Mesquite Stands	2.08
Planted Areas	0.25
Total =	11.52

With Project Condition (Alt. #2)
Potrero Creek Mitigation

Cover Type	AAHU
Cottonwood-Willow	6.64
Mixed Riparian	5.26
Mesquite Stands	2.08
Planted Areas	0.50
Total =	14.48

FORM D TABLES

CALCULATIONS OF NET CHANGES IN AAHU'S
BETWEEN DIFFERENT WITH PROJECT CONDITIONS AND
NO PROJECT CONDITION

Action: Alt. #1, No Mitigation
Compared to: Alt. #4 - No Action

Cover Type	AAHU's With Action	AAHU's Without Action	Net Change
Cottonwood-Willow	3.08	5.92	-2.84
Mixed Riparian	5.03	6.40	-1.37
Mesquite Stands	2.29	2.13	0.16
Planted Areas	0.26	0.00	0.26
Total	10.66	14.45	-3.79

Action: Alt. #1, With Potrero Creek Mitigation Component
Compared to: Alt. #4 - No Action

Cover Type	AAHU's With Action	AAHU's Without Action	Net Change
Cottonwood-Willow	5.56	5.92	-0.36
Mixed Riparian	5.10	6.40	-1.30
Mesquite Stands	2.29	2.13	0.16
Planted Areas	0.49	0.00	0.49
Total	13.44	14.45	-1.01

Action: Alt. #1, With Potrero Creek and Depression Area
Mitigation Components
Compared to: Alt. #4 - No Action

Cover Type	AAHU's With Action	AAHU's Without Action	Net Change
Cottonwood-Willow	6.18	5.92	0.26
Mixed Riparian	5.49	6.40	-0.91
Mesquite Stands	2.29	2.13	0.16
Planted Areas	0.49	0.00	0.49
Total	14.45	14.45	-0.00

Action: Alt. #2, No Mitigation
 Compared to: Alt. #4 - No Action

Cover Type	AAHU's With Action	AAHU's Without Action	Net Change
Cottonwood-Willow	4.00	5.92	-1.92
Mixed Riparian	5.19	6.40	-1.21
Mesquite Stands	2.08	2.13	-0.05
Planted Areas	0.25	0.00	0.25
Total	11.52	14.45	-2.93

Action: Alt. #2, With Potrero Creek Mitigation
 Compared to: Alt. #4 - No Action

Cover Type	AAHU's With Action	AAHU's Without Action	Net Change
Cottonwood-Willow	6.64	5.92	0.72
Mixed Riparian	5.26	6.40	-1.14
Mesquite Stands	2.08	2.13	-0.05
Planted Areas	0.50	0.00	0.50
Total	14.48	14.45	0.03

APPENDIX D

CULTURAL RESOURCES PROGRAMMATIC AGREEMENT

PROGRAMMATIC AGREEMENT

NOGALES WASH AND POTRERO CREEK

WHEREAS, the Corps of Engineers (COE) has determined that implementation of a flood control project at Nogales, Arizona may have an effect upon properties included in or eligible for inclusion in the National Register of Historic Places (National Register) and has consulted with the Arizona State Historic Preservation Officer (SHPO) pursuant to the regulation (36 CFR 800) implementing Section 106 of the National Historic Preservation Act (16 U.S.C. 470 f),

NOW, THEREFORE, COE and SHPO agree that if the Advisory Council on Historic Preservation (Council) accepts this Programmatic Agreement (PA) in accordance with 36 CFR 800.6 (a)(1)(i), the undertaking shall be implemented in accordance with the following stipulations in order to take into account the effect of the undertaking on historic properties.

STIPULATIONS

The COE shall ensure that the following stipulations are implemented.

1. **SURVEY:** Once access has been obtained by the COE, project areas along Potrero Creek and Nogales Wash which have not been investigated shall be surveyed for the presence of archeological and historic properties. The potential for buried sites shall be determined by a geomorphologist. Based on the referenced geomorphological assessment, back-hoe testing shall be performed, at intervals determined in consultation with the SHPO, to identify sites that may be buried. Boundaries of sites within the project area shall be determined and all sites shall be recorded on standard site record forms which shall include a site location map, a to-scale sketch map, photographic record and artifact drawings (as appropriate).

2. **TESTING:** All historic and prehistoric sites located during the above survey shall be evaluated for their eligibility for listing in the National Register, if possible. If such a determination is not possible with available information, a program for systematic testing (Testing Plans) shall be developed. The Testing Plans shall be developed in consultation with the SHPO, and shall be consistent with the Council's "Treatment of Archeological Properties: A Handbook" (Handbook) and "Archeology and Historic Preservation; Secretary of the Interior's Standards and Guidelines" (Federal Register Vol. 48, No. 190, pp. 44716-44742) (Standards). The final Testing Plans shall be submitted to the SHPO for review and comment. The SHPO shall provide its comments to COE within 30 days of receipt of full documentation. Failure of the SHPO to respond within 30 days shall not prohibit COE from authorizing implementation of the testing program. Should the SHPO have any objections to the final Testing Plans, COE shall consult with the SHPO to remove any objections. Should that consultation fail to remove the SHPO's objection, COE shall submit the proposed Testing Plans, together with the SHPO's comments, to the Council pursuant to Stipulation 6 (DISPUTES) below.

3. **EVALUATION:** Once the testing program, if deemed necessary, is completed, COE shall, in consultation with the SHPO, apply the National Register criteria to determine if any or all of the sites are eligible for listing in the National Register. Should both the COE and the SHPO determine that any of the sites are eligible, the site or sites shall be deemed eligible for the purposes of this Agreement. Should the COE and the SHPO disagree that some or any of the sites are eligible, the COE shall submit documentation to the Keeper of the Register for a formal determination of eligibility. Should COE and the SHPO agree that a site or sites are not eligible, such concurrence shall be, for the purposes of this Agreement, deemed conclusive that the site or sites are not eligible and need not be the subject of further consultation.

4. **TREATMENT PLAN AND DATA RECOVERY:** Should a site, or sites, be determined eligible for listing in the National Register, a Treatment Plan (TP) shall be developed to avoid, mitigate or negate the adverse effects of the undertaking. A Research Design (RD) guiding a data recovery program shall be developed in consultation with the SHPO for affected historic properties significant under criterion d of 36 CFR 60.4. The TP and the RD shall be consistent with the Handbook and Standards. The final TP and RD shall be submitted to the SHPO for review and comment. The SHPO shall respond to COE within 30 days of receipt of full documentation. Failure of the SHPO to respond shall not prohibit COE from authorizing implementation of the TP or RD. Should the SHPO have objections to either the TP or the RD, COE shall consult with the SHPO to remove those objections. Should those consultations fail to remove the objections, COE shall submit the proposed TP and/or RD, together with the SHPO's comments, to the Council for review pursuant to Stipulation 6 below.

5. **REPORTS:** Reports shall be prepared on the results of all archeological and historical investigations relating to this project. Copies of all reports shall be submitted to the SHPO, the Council, and, upon request, to other interested parties.

6. **DISPUTES:** Should a dispute arise between the SHPO and COE over aspects of either a Testing Plan, Treatment Plan or a RD that cannot be resolved through further consultation between the parties, COE shall submit the disputed document, together with SHPO's comments, to the Council. Within 30 days after receipt of all pertinent documentation, the Council's Executive Director will either:

a. refer the matter to the Chairman of the Council pursuant to 36 CFR Part 800.6(b)(7); or

b. provide COE with recommendations, which COE shall take into account in revising the disputed plan.

7. **TREATMENT OF HUMAN SKELETAL REMAINS:** COE shall ensure that a plan is developed for the treatment of human skeletal remains. The plan shall be developed in consultation with the SHPO and the representatives from the local Native American group (The Tohono O'otam Tribe of Arizona). Should the parties fail to agree upon a plan, COE shall submit full documentation of the proposed plan, together with any comments or objections from any of the parties, to the Council pursuant to Stipulation 6 above.

8. **DISCOVERY SITUATIONS:** Any previously unidentified archeological materials discovered after construction has begun shall be dealt with in accordance with 36 CFR 800 Part 800, and with 33 CFR Part 325 Appendix C as proposed April 3, 1980.

Execution of this Programmatic Agreement evidences that COE has afforded the Council a reasonable opportunity to comment on the undertaking and its effect on historic properties and that COE has taken into account the effects of this undertaking on historic properties.

CONSULTING PARTIES

U.S. Army Corps of Engineers (date)

Arizona State Historic (date)
Preservation Officer

ACCEPTED:

Advisory Council on (date)
Historic Preservation

APPENDIX E

404 (b)(1) WATER QUALITY EVALUATION

**THE EVALUATION OF THE EFFECTS
OF THE DISCHARGE OF DREDGED OR FILL MATERIAL
INTO THE WATERS OF THE UNITED STATES**

I. INTRODUCTION. The following evaluation is provided in accordance with Section 404 (b)(1) of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) as amended by the Clean Water Act of 1977 (Public Law 95-217). Its intent is to succinctly state and evaluate information regarding the effects of discharge of dredged or fill material into the waters of the U. S. As such, it is not meant to stand alone and relies heavily upon information provided in the environmental document to which it is attached.

II. PROJECT DESCRIPTION.

A. Location: The project is located along Nogales Wash in extreme southern Arizona in the County of Santa Cruz. See paragraph 1.1 in the EA.

B. General Description: The project is generally described in section 4 of the attached EA. Briefly, the project entails the construction of two lateral collector channels (LCC) on the U.S. side of the international border to capture overland sheet flow entering from Mexico and direct it into the two existing underground covered channels. Also, the project entails the construction of a flood control channel around the Chula Vista subdivision just north of the city of Nogales. The project also includes a flood warning system and a recreation plan.

C. Authority and Purpose: The project authority and purpose is documented in Sections 2 and 3 of the attached EA. Frequent flooding of the downtown portion of Nogales, Arizona and of the Chula Vista subdivision have resulted from increased urbanization of the watershed especially those portions located in Mexico. This study was authorized by Flood Control Act of 1938.

D. General Description of Dredged or Fill Material: A description of the dredged or fill material is in Section 4 of the attached EA. Briefly, the LCC's are entrenched concrete channels directing flows into concrete pipes attached to the two existing underground concrete channels. The CVC runs along the south and east side of the Chula Vista subdivision. The first 692 feet consists of a trapezoidal channel with a levee on the north side. Both the channel and levee are armored with grouted stone. The next 1,428 feet of the CVC consists of a rectangular concrete channel which then ties into 450 foot long grouted stone energy dissipating outlet structure with a trapezoidal cross section. Following the energy dissipator, the channel consists of an 800 foot long trapezoidal unlined channel daylighting to the natural channel.

E. Description of the Proposed Discharge Site: The LCC's will be constructed in a heavily urbanized area along the international

border between Nogales, Arizona and Nogales, Sonora. They will not be placed in any water body. The north-south trending portion of the CVC will be constructed along the natural same alignment of Nogales Wash for a distance of approximately 2,700 feet upstream of the confluence with Potrero Creek. The 692-foot east-west trending section will begin at Potrero Creek just south of the Pete Kitchen/Chula Vista community and run across a grazed pasture to Nogales Wash. The excess fill material will not be disposed of in any waterbody. Approximately 127,000 cubic yards of excess fill material will be disposed of at a horse ranch (location shown in figure 1 of the attached EA). Thus the remainder of this evaluation concentrates only on the north-south trending portion of the CVC.

III. FACTUAL DETERMINATIONS.

A. Disposal Site Physical Substrate Determinations:

1. Substrate Elevation and Slope:

Impact: N/A X INSIGNIF. SIGNIF.

All dredge and fill along Nogales Wash east of the Chula Vista subdivision is located very close to the natural alignment. With the project, future conditions would entail continued high water bank erosion with major changes to the physical substrate in this area.

2. Sediment Type:

Impact: N/A X INSIGNIF. SIGNIF.

Fill material will be grouted stone or concrete. Grouted materials will not release incompatible sediments into the river.

3. Dredged/Fill Material Movement:

Impact: X N/A INSIGNIF. SIGNIF.

Fill material will not move as it is hardened concrete or grouted stone. Fill materials placed in the lower portion of the river are expected to move as they will be placed downstream of the energy dissipator.

4. Physical Effects on Benthos (burial, changes in sediment type, composition, etc.):

Impact: N/A X INSIGNIF. SIGNIF.

Benthic life is not expected to suffer significant impacts. The existing conditions includes continuously heavily polluted water flowing from Mexico. Low flows and occasional absence of flows also contributes to a very limited benthic community.

5. Actions taken to Minimize Impacts

Needed?: ☒ YES ☐ NO. If Needed, Taken: ☒ YES ☐ NO

Due to high groundwater, construction will proceed along the CVC from upstream to downstream in order to allow dewatering of construction areas. Also, perennial Nogales Wash flows and nominal flood flows would be diverted to one side of the channel with temporary levees during construction of the invert and walls on the opposite side. These measures will reduce the amount of loose fill, unhardened concrete and other construction materials from entering the flows and being carried to downstream areas.

B. Effect on Water Circulation, Fluctuation, and Salinity Determinations:

1. Effect on Water. The following potential impacts were considered:

- a. Salinity ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
- b. Water Chemistry
(pH, etc.) ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
- c. Clarity ☐ N/A ☒ INSIGNIF. ☐ SIGNIF.
- d. Color ☐ N/A ☒ INSIGNIF. ☐ SIGNIF.
- e. Odor ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
- f. Taste ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
- g. Dissolved
gas levels ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
- h. Nutrients ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
- i. Eutrophication ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
- j. Others ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.

Clarity and color characteristics of the Nogales Wash flows may be temporarily altered by the construction activities. However, these impacts are considered minor and short term.

2. Effect on Current Patterns and Circulation. The potential of discharge or fill on the following conditions were evaluated:

- a. Current Pattern and Flow
☐ N/A ☒ INSIGNIF. ☐ SIGNIF.
- b. Velocity
☐ N/A ☒ INSIGNIF. ☐ SIGNIF.
- c. Stratification
☐ N/A ☒ INSIGNIF. ☐ SIGNIF.
- d. Hydrology Regime
☐ N/A ☒ INSIGNIF. ☐ SIGNIF.

3. Effect on Normal Water Level Fluctuations. The potential of discharge of fill on the following were evaluated:

- a. Tide ☒ X ☐ N/A ☐ INSIGNIF. ☐ SIGNIF.
- b. River Stage ☒ X ☐ N/A ☐ INSIGNIF. ☐ SIGNIF.

C. Suspended Particulate/Turbidity Determinations at the Disposal Site:

1. Expected Change in Suspended Particulate and Turbidity levels in Vicinity of Disposal Site:

Impact: ☐ N/A ☒ X ☐ INSIGNIF. ☐ SIGNIF.

All turbidity and suspended particulate impacts are expected to be minor and short term during construction.

2. Effects (degree and duration) on Chemical and Physical Properties of the Water Column:

- a. Light Penetration
☐ N/A ☒ X ☐ INSIGNIF. ☐ SIGNIF.
- b. Dissolved Oxygen
☒ X ☐ N/A ☐ INSIGNIF. ☐ SIGNIF.
- c. Toxic Metals & Organic
☒ X ☐ N/A ☐ INSIGNIF. ☐ SIGNIF.
- d. Pathogen
☒ X ☐ N/A ☐ INSIGNIF. ☐ SIGNIF.
- e. Esthetics
☐ N/A ☒ X ☐ INSIGNIF. ☐ SIGNIF.

3. Effects of Turbidity on Biota: The following effects of turbidity on biota were evaluated:

- a. Primary Productivity
☒ X ☐ N/A ☐ INSIGNIF. ☐ SIGNIF.
- b. Suspension/Filter Feeders
☐ N/A ☒ X ☐ INSIGNIF. ☐ SIGNIF.
- c. Sight feeders
☐ N/A ☒ X ☐ INSIGNIF. ☐ SIGNIF.

D. Contaminant Determination:

The following information has been considered in evaluating the biological availability of possible contaminants in dredged or fill material.

1. Physical characteristics.
2. Hydrography in relation to known or anticipated source of contaminants.

An evaluation of the appropriate information above indicates that there is reason to believe the proposed dredge or fill material is not a carrier of contaminants, or that levels of contaminants are substantively similar at extraction and disposal sites and not likely to be constraints. The material meets the testing exclusion criteria.

YES ☒ NO ☐

Impact: ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.

E. Effect on Aquatic Ecosystem and Organism Determinations:
The Following ecosystem effects were evaluated:

1. On Plankton ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
2. On Benthos ☐ N/A ☒ INSIGNIF. ☐ SIGNIF.
3. On Nekton ☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
4. Food Web ☐ N/A ☒ INSIGNIF. ☐ SIGNIF.
5. Sensitive Habitats:
 - a. Sanctuaries, refuges
☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
 - b. Wetlands
☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
 - c. Mudflats
☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
 - d. Eelgrass beds
☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
 - e. Riffle and Pool Complexes
☐ N/A ☒ INSIGNIF. ☐ SIGNIF.
6. Threatened & Endangered Species
☒ N/A ☐ INSIGNIF. ☐ SIGNIF.
7. Other Wildlife (grunion, trout)
☒ N/A ☐ INSIGNIF. ☐ SIGNIF.

F. Proposed Disposal Site Determinations: Is the mixing zone for each disposal site confined to the smallest practicable zone?

☒ YES ☐ NO

G. Determination of Cumulative Effects of Disposal or Fill on the Aquatic Ecosystem:

Impacts: ☐ N/A ☒ INSIGNIF. ☐ SIGNIF.

Much of Nogales Wash is in a natural state. Development along the Wash has progressed very slowly over the years. Thus, cumulative effects are considered to be insignificant.

H. Determination of Indirect Effects of Disposal or Fill on the Aquatic Ecosystem:

Impacts: ☐ N/A ☒ INSIGNIF. ☐ SIGNIF.

Indirect effects on the aquatic ecosystems of Potrero Creek and Nogales Wash will be avoided as the mitigation plan proposes to secure from future development those unchannelized portions of Potrero Creek to a width of at least 30 feet on each side of the creek.

IV. FINDING OF COMPLIANCE.

A review of the proposed project indicates that:

a. The discharge represents the least environmentally damaging practicable alternative and if in a special aquatic site, the activity associated with the discharge must have direct access or proximity to, or be located in the aquatic ecosystem to fulfill its basic purpose

☒ YES ☐ NO

b. The activity does not appear to: 1) violate applicable state water quality standards or effluent standards prohibited under Section 307 of the CWA; 2) jeopardize the existence of Federally listed endangered or threatened species or their habitat; and 3) violate requirements of any Federally designated marine sanctuary.

X YES NO1

c. The activity will not cause or contribute to significant degradation of waters of the U.S. including adverse effects on human health, life stages of organisms dependent on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values;

 X YES NO1

d. Appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem.

 X YES NO

On the Basis of the Guidelines, the Proposed Disposal Site(s) for the Discharge of Dredged or Fill Material (specify which) is (select one):

- (1) Specified as complying with the requirements of these guidelines; or,
- X (2) Specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem; or,
- (3) Specified as failing to comply with the requirements of these guidelines.

Prepared by: David Castanon
Name

Geographer
Position

Date: August 7, 1987

1 A negative response indicates that the proposed project does not comply with the guidelines.

APPENDIX F

RESPONSE TO COMMENTS
ON THE
DRAFT ENVIRONMENTAL ASSESSMENT



ARIZONA STATE PARKS

800 W. WASHINGTON
SUITE 415
PHOENIX, ARIZONA 85007
TELEPHONE 602-255-4174

EVAN MECHAM
GOVERNOR

STATE PARKS BOARD MEMBERS

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TUCSON

RONALD PIES
TEMPE

M. JEAN HASSELL
STATE LAND COMMISSIONER

KENNETH E. TRAVOUS
EXECUTIVE DIRECTOR

COURTLAND NELSON
DEPUTY DIRECTOR

August 19, 1987

Dr. Nedenia Kennedy
Staff Archaeologist
Environmental Branch
U.S. Army Corps of Engineers
Los Angeles District
300 N. Los Angeles Street
P.O. Box 2711
Los Angeles, CA 90053-2325

Re: Nogales Wash and Potrero Creek Proposed MOA, DOD-CORPS

Dear Dr. Kennedy:

We have reviewed the draft Memorandum of Agreement (MOA) prepared for the proposed implementation of a flood control project located at Nogales, Arizona along Potrero Creek and Nogales Wash. In general, the draft agreement looks very good. We have only two comments:

1. The evaluation of National Register eligibility for sites located during the survey should be conducted prior to testing, if possible. Following stipulation #1 there should be a statement that notes that all historic and prehistoric archaeological sites located during the survey will be evaluated for their National Register eligibility, if possible. If such a determination is not possible, a program for systematic testing will be conducted.

1

2. If there is agreement between the Corps and this office, the MOA need only be signed by two parties, pursuant to 36 CFR Part 800. The MOA should be submitted to the Council for their review but they need not be a signator unless the Corps, SHPO or Council request it.

2

We appreciate your continued cooperation with this office. If you have any questions, please contact me.

Sincerely,

Shereen Lerner Ph. D.
State Historic Preservation Officer



ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

EVAN MECHAM, GOVERNOR
GERALD H. TELETZKE, PH.D., DIRECTOR

December 10, 1987

Mr. Tadahiko Ono
Colonel, Corps of Engineers
Water Resources Branch
P. O. Box 2711
Los Angeles, California 90053

Dear Sir:

Thank you for the opportunity to comment on the "Draft Feasibility Report and Draft Environmental Assessment for the proposed Nogales Wash and Tributaries Nogales, Arizona" (Arizona State Clearinghouse #87800059).

Construction activities in stream beds should be conducted in compliance with the States "Policy on Construction and Related Activities in Water" (copy attached). 3

Dangerous biological contaminants have been documented in Nogales Wash near the International Boundary. Any downstream recreational developments should address potential pathways for waterborne and vectorborne disease transmission. 4

If you have any question on these comments, please contact Ed Swanson at 392-40443.

Sincerely,

A handwritten signature in cursive script that reads "Susan Monroe".

Susan Monroe, Planner
Office of Planning &
Program Development

cc: Arizona State Clearinghouse
Ed Swanson

The Department of Environmental Quality is An Equal Opportunity Affirmative Action Employer

F-2

Central Palm Plaza Building

2005 North Central Avenue

Phoenix, Arizona 85004

ARIZONA DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL HEALTH SERVICES
BUREAU OF WATER QUALITY CONTROL

POLICY ON
CONSTRUCTION AND RELATED ACTIVITIES IN WATER

Appropriate items as listed below should be included in specifications for construction and related activities in waterways. Adherence to the cited procedures should assure compliance with Water Quality Standards for Surface Waters, R9-21. Specifications should require the person responsible for the activity to submit a program for effective control of water pollution to the person in charge of the project which includes procedures for protecting water from pollution with fuels, oils, bitumens, calcium chloride and other harmful materials, and for conducting and scheduling operations so as to avoid or minimize muddying and silting of the water.

Specific procedures for preventing water pollution may include:

1. Provision for temporary pollution control measures including dikes, basins, ditches and application of straw and seed.
2. Erosion control measures including minimizing clearing and grubbing and limiting exposure of erodable surface to 750,000 square feet for each location.
3. Construction of footings in water by sheet pile cofferdam method and pumping water from within the dam to settling ponds before returning it to the water.
4. Isolation of the construction area by sand dikes.
5. Erection of barriers, covers, shields and other protective devices as necessary to prevent any construction materials, equipment or contaminants from falling or being thrown into the water.
6. Construction of drainage facilities to control erosion and sedimentation.
7. Provision of an adequate means, such as a bypass channel, to carry a stream free from mud and silt around operations to remove material from beneath a flowing stream.
8. A requirement for transportation of materials across live streams to be conducted without muddying the stream, mechanized equipment should not be operated in stream channels of live streams except as may be necessary to construct crossings or barriers and fills at channel changes.

POLICY ON CONSTRUCTION AND RELATED ACTIVITIES IN WATER
Page 2

9. A requirement for wash water from aggregate washing or other operations containing mud or silt to be treated by filtration or retention in a settling pond, or ponds, adequate to prevent muddy water from entering live streams.
10. A requirement for oily or greasy substances originating from the contractor's operations not be placed where they will later enter a live stream.
11. Provisions for Portland cement or fresh Portland cement concrete not to be allowed to enter flowing water of streams.
12. A requirement to return the flow of streams as nearly as possible to a meandering thread without creating a possible future bank erosion problem when operations are completed.
13. A requirement that material derived from roadway work should not be deposited in a live stream channel where it could be washed away by high stream flows.

The person responsible for the activity should be required to monitor for turbidity every day in which there is a disturbance of the bed of the waterway. Monitoring should be performed not greater than one and one-half miles downstream from the construction or related operations and weekly reports of turbidity measurements should be reported to the water quality control agency.

4/13/77

EVAN MECHAM, Governor

Commissioners:
FRED S. BAKER, Elgin, Chairman
LARRY D. ADAMS, Butte City
FRANCES W. WERNER, Tucson
THOMAS G. WOODS, JR., Phoenix
PHILLIP W. ASHCROFT, Esq.,

Director
TEMPLE A. REYNOLDS

Assistant Director
DUANE L. SHROUPE

ARIZONA GAME & FISH DEPARTMENT

2222 West Gregory Road Phoenix, Arizona 85023 942-3000

December 16, 1987

Colonel Tadahiko Ono, District Engineer
U. S. Army Corps of Engineers
Los Angeles District
P. O. Box 2711
Los Angeles, California 90053-2325

Attn: Mr. Paul Balkey, Water Resources Branch

Dear Colonel Ono:

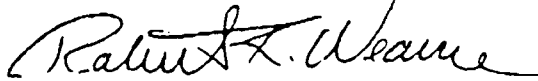
Re: Nogales Wash and Tributaries
Draft Feasibility Report and
Environmental Assessment

The Arizona Game and Fish Department has reviewed the above-referenced document, and has found that it accurately and adequately describes the project and its impacts on biotic resources.

However, we strongly recommend including an additional wetland in section 4.3, subsection 1, page 9, of the draft EA. The wetland is located between I-19 and U.S. 89, in association with Portrero Creek, and should be acquired as mitigation for this project. This wetland provides nesting habitat for the black-bellied whistling duck (Dendrocygna autumnalis fulgens), an Arizona Group 4 threatened native wildlife species.

Thank you for the opportunity to review and comment on this document.

Sincerely,


Robert K. Weaver
Habitat Evaluation Coordinator
Planning and Evaluation Branch

RKW:11

cc: Sam Spiller, Field Supervisor, USFWS, Phoenix ES Office
Tom Spalding, Supervisor, Tucson Regional Office
Bruce Palmer, Nongame Habitat Specialist



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

ECOLOGICAL SERVICES
3616 W. Thomas, Suite 6
Phoenix, Arizona 85019

December 18, 1987

Colonel Tadahiko Ono
District Engineer
ATTN: Paul Blakey, Water Resources Branch
U.S. Army Corps of Engineers
P. O. Box 2711
Los Angeles, CA 90053-2325

Dear Colonel Ono:

This responds to your request for comments on the draft Feasibility Report and draft Environmental Assessment for the proposed Nogales Wash and Tributaries, Nogales, Arizona flood control project. The Fish and Wildlife Service has reviewed the subject draft documents and would like to offer the following comments for your consideration.

General Comments

Overall we believe that the documents are complete and adequately address the issues involved with this flood control project.

The mitigation plan presented in the documents would fully mitigate for the project related losses in riparian areas. It includes both vegetative enhancement and acquisition of existing habitats to provide mitigation areas. Additional high value wetland and riparian habitats occur within the drainage basin that may be useful for any further consideration given to mitigation, especially if the present mitigation plan is reviewed for potential modification. An example of these areas would be the wetland located on Potrero Creek, upstream of the project area near Interstate 19.

More information concerning the aesthetic treatment along the Chula Vista Channels (CVC) should be presented in the documents. The feasibility report states that an easement of 10-feet per side of a project is usually acquired. The placement of 10-foot paved maintenance roads on either side of the Chula Vista-Nogales Wash Channel (pages 5-14) may preclude the placement of riparian vegetation in the area except in the 1-tree thick screen. Please elaborate on the actual width and length of these planting areas.

We recommend that as part of the mitigation package, a set of specific management directions be developed for the riparian mitigation areas. These should address watering, planting of replacement vegetation, pruning and trimming, use of herbicides and other related information. We believe that a monitoring plan would be necessary to ensure that trees were planted and survive. Plans for replacement of failed plantings would also be essential.

Specific Comments

Page 2-1, Section A, 2nd paragraph - Perhaps a figure showing the stream nomenclature to be used would clarify this paragraph.

Page 3-16, Table 14 - Add "portion" to "Max. supply in the U.S. _____ of the study area."

Page 4-31 - The last sentence on page 4-31 to page 4-32 appears to be inappropriate.

Page 5-5,5-6, Table 23 - Further discussion is needed in the text of the feasibility report concerning the 20-25 acres of land that would be removed from the floodplain subject to development.

Page 5-14 - Dewatering the construction area should not effect adjacent riparian areas.

Page EA-7 - Techniques developed by the Soil Conservation Service for pole planting in Arizona should be considered. 9

Page EA-13, Section 6.1 - Please clarify the status of riparian resources on the disposal site. 10

Page EA-21 - Will the right-of-way be planted to be cottonwood-willow and mesquite, or only cottonwood-willow? 11

Page EA-26, Section 7.5.2 - The affect of lowering the ground water on riparian vegetation needs to be addressed. 12

Page HEP-13 - If the lands identified for mitigation would cost more than \$1,000/acre, would they still be acquired, or would the amount of mitigation land purchased be reduced to maintain stated mitigation costs? 13

Thank you for the opportunity to comment on these documents. If we may be of further assistance, please contact Ms. Lesley Fitzpatrick or me (Telephone: 602/261-4720).

Sincerely,



Sam F. Spiller
Field Supervisor

cc: Regional Director, Fish and Wildlife Service, Albuquerque, New Mexico
(Fish and Wildlife Enhancement)
Director, Arizona Game and Fish Department, Phoenix, Arizona



OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO
THE COMMONS, BUILDING C, SUITE 310
4171 NORTH MESA
EL PASO, TEXAS 79902

DEC 24 1937

District Engineer
U.S. Army Corps of Engineers
Attn: Mr. Paul Blakey
Water Resource Branch
P.O. Box 2711
Los Angeles, California 90053-2325

Dear Sir:

We have reviewed the Draft Feasibility Report and Draft Environmental Assessment for the Proposed Nogales Wash and Tributaries, Nogales, Arizona Project. We have no objection to the "Plan Tentatively Selected for Implementation? However, we will have to discuss the plan with the Mexican Section to obtain permission for installation of the self reporting rain and stream gages in Mexico.

The report is very comprehensive. However, we feel that the report could be made more readable if much of the material on the Corps planning procedures was left out. At the same time, we feel that more detail is needed on the economic analysis. We presume that the first costs were converted to annual costs. If so what interest rate and period of time were used. Also, more information on the flood frequency analysis is needed. It is not clear how you can have two different frequencies for the same flow. In addition, it is not clear as to what would happen if the inlets to the existing covered channels were cleaned out.

As mentioned in the report the U.S. Section is working with the City of Nogales on the enlargement of the Nogales International Wastewater Treatment Plant. However, there are no plans to enlarge the capacity of the present sewer line from Mexico.

Attached are more detailed comments.

Sincerely,

Thomas P. Wootton
Division Engineer, Planning

Attachment:
As Stated

DETAILED COMMENTS ON
CORPS OF ENGINEER'S DRAFT FEASIBILITY
REPORT AND ENVIRONMENTAL ASSESSMENT
NOGALES WASH AND TRIBUTARIES, NOGALES, ARIZONA PROJECT

- Syllabus Delete 3rd sentence "Potential solutions..."
- Page VI LIST OF FIGURES, Figure 14 should be shown on page 4-16 and Figure 15 on page 4-17
- Page 1-7 First line under *FEDERAL delete "Department of State" and insert "U.S. Section"
- Page 2-3 Last paragraph, revise second sentence to read "Dry weather flow is fed by springs, however, some sewage contributes to the flow in the wash through Nogales, Sonora."
Last sentence how can one flow have two frequencies
- Page 2-16 First full paragraph, second sentence not consistent with Table 8 suggest rewrite, "About 74 percent of the present day population is of Spanish heritage, and most all of the population has some ability with the Spanish language."
- Page 3-2 Second paragraph under "2. Historical Flood Damages" 3rd line delete "significant". We are not aware of any significant damage to the International Waste Water Treatment Plant.
Last paragraph on page is confusing along with Tables 12A-12D. A flow should have the same frequency whether it occurs now or in the future. The damage could be different with and without a project.
- Page 4-4 First paragraph, third sentence delete "Federal project (or future without a project)" and insert "action"
- Page 4-5 D. PLANS BY OTHERS, first paragraph, last sentence revise as follows, "The following project in the study is currently under consideration"
Suggest 2. International Waste Water... be deleted in its entirety. Although the U.S. Section, IBWC is working with the City of Nogales, Arizona on expanding the capacity of the existing treatment plant it would not impact on the Corps proposed project. Only a portion of the proposed site shows up on Fig. 4. There will be no increase in the size of "the main trunk line" from Mexico.
- Page 4-6 a. First iteration, second paragraph, first sentence. It is not clear in Table 15 and the text if the construction costs were converted to annual costs. If so what was the period and interest rate used.
b. Second iteration, first paragraph, revise the first sentence to read "In December 1984, the U.S. Commissioner, International Boundary and Water Commission, United States and Mexico, advised the Los Angeles District Engineer (D.E.) that Mexico was not interested in joining in a study of flood control works in both countries."
Second paragraph same comment as under First iteration
c. Reconnaissance phase recommendations, first paragraph reference is made to Table 17 and the flood warning system but Table 17 does not show the flood warning system.

Page 4-12 2. Feasibility Phase, fourth paragraph see comments for page 3-2
Third line from bottom change "sownstream" to "downstream" last sentence is incomplete.

Page 4-19 Third paragraph, what is the basis for future conditions.
Delete last sentence on page as it is repeated on next page.

Page 4-31 (2) 100-YEAR CHULA VISTA CHANNELS
First paragraph, fifth line, change "condisered" to "considered"
Second paragraph, fourth line, change "Pacific rail lined" to "Pacific Railway"
Third paragraph 1st line delete "on" insert "of" delete "amount of"

Page 4-32 First line - delete
(3) 20-YEAR CHULA VISTA CHANNELS
First paragraph, third line refers to Plates 10 and 11 there are no Plates 10 and 11.

Page 4-40 C. Alternative 3A
First paragraph, last line, delete one of the "in" s

Page 4-41 d. Alternative 3B
First paragraph, third line change illusterates" to Illustrates"

Following Page 4-44 Figures 23, 24, and 25 the red dot for Chula Vista and Firestone Gardens should be black.

Page 5-1 a. Lateral collection channels
Second paragraph, sixth line, change "four" to "three"

Page 5-2 c. Flood warning system
Description not consistent with that on Page 4-32
Figure 27, replace red dot for Chula Vista with black dot

Page 5-5 Table 23, first line change "floods" to "flood"

Page EA-17 6.5.3 Water Quality
Fifth and seventh lines change "treatment" to "collection"
There is no treatment in Nogales, Sonora all sewage that is collected and conveyed to the international boundary is treated in the International Wastewater Treatment Plant 14

Page EA-18 Last paragraph fourth line, insert "is" after "and" 15

Page EA-23 b. Alternative 2
Fourth line, change "the" to "there" 16

Page EA-26 Last paragraph, second sentence, change to read "The sewage flowing from Mexico is expected to continue unchanged after the project is constructed." 17

Page EA-35 p. Executive Order 12114..
fifth line insert "U.S. Section" before International 18
sixth line insert "U.S. Section" before IBWC

Page EA-36 Insert "U.S. Section" before International 19



Arizona Department of Water Resources

Engineering Division
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Evan Mecham, Governor
Alan P. Kleinman, Director

December 30, 1987

District Engineer
Engineer U.S. Army Corps of Engineers
Mr. Paul Blakey, Water Resource Branch
Post Office Box 2711
Los Angeles, California 90053-2325

SUBJECT: Nogales Wash Draft Feasibility Report and
Environmental Assessment

Dear Mr. Blakey:

Thank you for the opportunity to review the subject report and assessment. The following comments are offered after careful review of both the feasibility report and environmental assessment by my staff:

In chapter 2; "Resources and Economy of the Study Area", I was surprised to see no mention of the economic effects of the devaluation of the Peso. This devaluation has had tremendous economic effects on all border communities.

In chapter 3; "Problem Identification and Opportunities", water quality issues did not indicate that contamination of the groundwater by TCE (and other volatile organics) has been found at the C. G. Conn's waste pond which is adjacent to Nogales Wash.

20

In chapter 4; "Plan Formulation", the report states that expected flood levels are less than floor elevations at produce warehouses in the Valle Verde area, thus damages would be minimal. This is true, but access to the docks would be restricted after the flood due to sediment deposits which would have to be removed prior to resumption of normal operations.

In the same chapter, the description of the proposed flood warning system is unclear and seems incomplete; repeaters are mentioned but locations are not shown on map(s); since repeaters are mentioned, one could assume the system will be radio telemetered, yet satellite telemetry is called for without addressing channel assignment and licensing; some locations of stream gauges and precipitation gauges could be improved; siren on the upper Potrero Creek gauge will not be heard by anyone if located where proposed.

If satellite telemetry is to be used there is no need for

be a need for one or more repeaters because of line-of-sight requirements. The "Base Station" or "Receive Site" will require the mentioned microcomputer but will also require appropriate software, receive antenna and cable.

The one hour lead time seems unlikely for some of the tributary locations.

The O&M costs associated with the flood warning system seem about three times too high. A reasonable rule of thumb is about 10% of the initial capital investment.

The implementation of any flood warning system in Arizona should be closely coordinated through the Arizona Department of Water Resources and the National Weather Service in order to insure compatibility, non-interference with neighboring systems, promote data exchange, and fit into the State/Federal planned network of local flood warning systems.

In chapter 5; "Plan Tentatively Selected for Implementation", mention is made of an existing "Civil Defense System" which is supposed to interrogate the self-reporting sensors. Self-reporting sensors need no interrogation. Appropriate software is available for microcomputers to receive and assimilate data from sensors and formulate a flood forecast. A good "Response Plan" (including evacuation plans) is also needed and this may be the Civil Defense System mentioned in the report.

In the "Environmental Assessment", it seems like a very good idea (as called for in the assessment) to fence off from grazing the proposed riparian area along Potrero Creek .

Overall the report had very good graphics, is well organized and concisely written with great attention to detail. There are numerous typographic errors remaining in the manuscript. A wide spectrum of structural and non-structural alternatives was evaluated but no alternative considered improving the hydrologic response of watersheds.

Hydrologic response is highly influenced by watershed condition. Hydrologic regimes can be "restored" by direct watershed treatment methods and implementation of best land use practices. Relatively inexpensive methods of watershed restoration such as manipulation of vegetation, contour ripping, seeding, gully plugs and check dams can dramatically reduce peak flows by enhancing the on-site retention/detention potential of the contributing land area. Such methods are relatively economical, in line with the natural system, improve water quality by enhancing natural recharge, lower sediment yields, upgrade land productivity, and have lower associated O&M costs.

Of course, watershed restoration methods would not be stand

alone flood control alternatives. Furthermore, they require extensive coordination of numerous agencies. Then there is the question of Mexico's 48% of the watershed. The difference in watershed condition along the border is visible on Landsat photography. If Mexico's watersheds can not be restored because of political barriers, the L.C.C.s must remain in the implemented alternative.

All expected flood peaks were probably estimated using the controversial Log Pearson Type III method but this is not verifiable from the draft text, (were based on FEMA-FIS). Also unclear is the method used to determine future conditions and corresponding peak flows.

Engineering drawings and construction plans seem very reasonable for the given conditions. The assumption that the release hydrograph from the "proposed" (by separate study) Ephriam Canyon Dam will be the same as the present condition hydrograph seems debatable.

Recreational demand being so much higher than the level provided by the selected plan means that there could be over-use impacts on areas made available if some form of limiting is not enforced. Limits of use on a user-day basis would be necessary to prevent degeneration of recreational areas by exceeding their carry capacities.

Flood depths and pre-development condition of the Chula Vista area indicate that this area is a marsh or at least a wet meadow in its natural state. The existence of upstream marshes should make this obvious. The subdivision will experience shallow ground water problems if it has not already. Structural cracking due to settling and seasonal contraction and expansion of the soils reflecting seasonal variations in soil-moisture would not be too surprising. In its natural state this area would serve as "dead storage attenuation" of downstream peak flows and as a natural recharge zone. I strongly favor relocation. The proposed by-pass channel could de-water a large area, thus endangering riparian habitat.

Nogales Wash below Potrero Creek is referred to as Potrero Creek rather than Nogales Wash. Some of the washes in Mexico are referred to as unnamed but they do have names.

Please contact Jim Morris of my staff at 1-602-255-1541 if you have any questions or if we can be of further assistance.

Sincerely,


Doug Toy,
Deputy Director

RESPONSE TO COMMENTS
ON THE
DRAFT ENVIRONMENTAL ASSESSMENT

The discussion below addresses those comments on the Draft EA received during public review of the Draft EA. The numbered responses correspond to the comments as numbered on the preceding letters.

Arizona State Parks:

1. Agreed. The Programmatic Agreement currently being coordinated between the Corps and the State Historic Preservation Officer will be modified to incorporate this comment.
2. Noted. The Programmatic Agreement will be modified accordingly.

Arizona Department of Environmental Quality:

3. Corps of Engineer Regulations include many strict stipulations concerning prevention of water pollution and other unnecessary environmental degradation. These stipulations are routinely included in all plans and specifications for construction of flood control channels. These specifications will satisfy State "Policy on Construction and Related Activities in Water" to the maximum practical extent.

4. This project will not improve or degrade water quality in Nogales Wash with respect to the biological contaminants flowing in from Mexico. Only one of the three recreational sites (table and ramada) will be along Nogales Wash. No increase in water or vector-borne disease transmission is expected due to the fact that the residents at Chula Vista Community currently live adjacent to Nogales Wash without any physical barriers to contact with the water. However, after construction, the Chula Vista Channel will be fenced thereby severely reducing the ability of local residents to come in contact with the water.

Arizona Game and Fish Department:

5. The Corps does not agree that acquisition of this wetland area is appropriate or necessary for mitigating the impacts of this project. The recommended mitigation plan fully mitigates for project impacts to biological resources. Further, Corps policy is to mitigate on project lands first, then adjacent lands. In addition, Corps mitigation policy is to preferentially mitigate on public lands rather than private lands. Also, the U.S. Fish and Wildlife Service is on record as designating the habitat impacted as "Resource Category 2". The mitigation for this habitat designation is no net loss of in-kind habitat value. Therefore, insofar as the project is impacting primarily riparian habitat, mitigation by acquisition of a privately owned offsite wetland would not be appropriate nor in compliance with Corps or USFWS policy.

U.S. Fish and Wildlife Service:

6. The Corps agrees that the recommended mitigation plan fully mitigates for project related impacts. However, for the reasons identified in response #5, above, it is inappropriate to acquire the wetland area in question. Further, that wetland area is under Corps permit jurisdiction for discharge of dredge or fill material (Section 404 of the Clean Water Act) and thus it is questionable as to whether it will be destroyed by development in the future. If the loss of the habitat values at the site is in question, then so is any expected mitigation credits that would be gained by preserving the site through acquisition.

7. The aesthetic treatment plan includes sufficient space on each side of the channel for planting of riparian habitat. The Feasibility Main Report has been modified to clarify this question. The aesthetic treatment plan includes planting of approximately 2.5 acres of the project Right of Way (exclusive of the paved access roads).

8. The mitigation plan will be designed for minimum Operation and Maintenance requirements. However, during the next study phase (Preconstruction Engineering and Design) limited specific management directions for implementation and maintenance of the mitigation plan and a construction monitoring plan will be developed.

9. The SCS pole-planting techniques utilized in Arizona will be investigated during the next study phase and may be utilized in the implementation of the mitigation plan. Such techniques are certainly not precluded.

10. The riparian resources of the disposal site were surveyed in February of 1988. The results of this survey are presented in Chapter 6 (Existing Environment) of the EA.

11. The mitigation areas along Potrero Creek will be planted to be Cottonwood-Willow as these species are typically found closer to water and that creek will have perennial low flow. All other mitigation areas (i.e., along the Chula Vista Channel) will be planted with Cottonwoods, Willows, and Mesquites. These areas may not have quite as much ground water available, but will be irrigated. Also, including mesquites in some of the mitigation areas assures greater habitat diversity.

12. No significant impacts are anticipated due to the minor lowering of the groundwater table in the close vicinity of the Chula Vista Channel. The mitigation areas along Potrero Creek will not be impacted by the lowered groundwater table. The mitigation areas along Nogales Wash will be irrigated and hence will not be imperiled by the slightly lowered groundwater immediately along the Channel.

13. Land costs were not evaluated in the development of mitigation goals. Mitigation goals were established on a habitat unit basis. Once the mitigation goals were set (in terms of habitat units desired) various mitigation options are identified. These options were then evaluated in terms of cost efficiency and compliance with Corps mitigation policy. The intent of the incremental mitigation analysis is to develop a recommended mitigation plan that best meets the mitigation goal and is in compliance with Corps mitigation policy. Deviation from Corps policy must be well justified economically. Thus, land costs are not

necessarity of overriding concern and they do not influence establishment of mitigation goals.

International Boundary and Water Commission:

14. This comment is noted and the EA is modified accordingly.
15. Noted.
16. Noted.
17. This comment is noted and the EA is modified accordingly.
18. This comment is noted and the EA is modified accordingly.
19. This comment is noted and the EA is modified accordingly.

Arizona Department of Water Resources:

20. Informal telephone coordination with Mr. Rob Genualdi of the Arizona Dept of Water Resources, Remedial Action Division indicates that the groundwater contamination from the C. G. Conn plant has resulted in the general northeast migration of the plume towards the Chula Vista Community. However, this plume has not yet reached the I-19 and U.S.-89 freeways. Thus, the plume is sufficiently far from the Corps proposed Chula Vista Channel such that no groundwater problems are anticipated. The plant where the problem originated is coordinating with the State and EPA in an effort to minimize migration of the plume.

21. The Corps agrees with this comment.